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September 30, 1926

Engineering Library

Engineering News-Record

Bridging the Delaware River at Philadelphia-I —Experiments on Hydraulic Jump in Sewer Connections—Puddle Core Investigations at Tieton Dam, Washington—Refuse Disposal Practice in Six British Municipalities—Construction Work on a Chinese Railway

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Federal Roofs *are erected* With Masterly Speed

FEDERAL Cement Tile Roofs are laid with speed by installation experts, who have devoted years of study to the mastery of roofing problems.

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And back of every Federal Roof stands a guarantee that for a quarter of a century has assured freedom from roof repairs on every type of permanent building.

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Federal pre-cast concrete slabs come to the job ready for quick placing from box car to roof the year round. They are fire-proof, have uniform strength, and are light in weight. For all flat and pitched surfaces. Glass Insert Tile interchange with Interlocking Tile for top-lighting, thus forming "The Daylight Roof"

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FEDERAL CEMENT TILE COMPANY
608 South Dearborn Street, Chicago, Illinois

FEDERAL CEMENT TILE ROOFS

"For Every Type of Permanent Building"

Volume 97 New York, September 30, 1926 Number 14

Engineering News-Record

A CONSOLIDATION OF ENGINEERING NEWS, ENGINEERING RECORD, THE SANITARY ENGINEER, AND THE CONTRACTOR

New York
M. N. BAKER F. E. SCHMITT
C. S. HILL V. T. BOUGHTON
J. W. SHAVER W. G. BOWMAN

FRANK C. WIGHT, *Editor*

Chicago
E. E. R. TRATMAN
W. W. DE BERARD
On Leave of Absence
San Francisco
N. A. BOWERS

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PROJECT a century old realized at last by public enterprise on a basis of amortization of cost by tolls. Many new problems. Rapid construction results in opening bridge before predicted day.
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Refuse Disposal Practice in Six British Municipalities 536
BY JOHN B. C. KERSHAW.
RECOVERY OF PAPER, metals, fuel and other utilizable material and burning of combustible residue in heat-producing destructors by five cities. Use of refuse for land reclamation.
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Water Inlet, Screen and Aerator for Liverpool Water Filters 539
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Construction Work on a Chinese Railway 540
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GRADING, tunnels, bridges and culverts. Tunnel with roof of concrete blocks and walls of varied types. Riprap on fills along river. Compressed-air foundations.
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Puddle Core Investigations at Tieton Dam, Washington 544
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Coming:

An Engineer's Interpretation of the Florida Disaster

AS ANNOUNCED in the news section of last week's issue, F. E. Schmitt, associate editor of *Engineering News-Record*, is now in Florida investigating the effects of the hurricane which swept across the southern part of that state Sept. 18. His mission is to report on the condition of engineering structures of various types in the storm zone and to suggest how the structural lessons learned from the Florida disaster may be applied to reduce or eliminate damage under similar conditions in the future.

For this exacting task Mr. Schmitt, a member of the Committee on Research of the American Society of Civil Engineers, is eminently qualified. Similar assignments which he has handled with signal success in the past include the failure of the Quebec Bridge and the collapse of the Knickerbocker Theater at Washington, D. C.

REPORTS in the daily press of disasters like that which has overtaken Florida give a hurried picture of physical damage and human suffering, but offer the engineer and the constructor little, if any, information of a technical nature which may serve to interpret the damage in structural terms. Readers of *Engineering News-Record*, therefore, may look to Mr. Schmitt's forthcoming reports from the Florida tornado zone to supply this deficiency. This issue contains the first news report. More thorough studies will follow.

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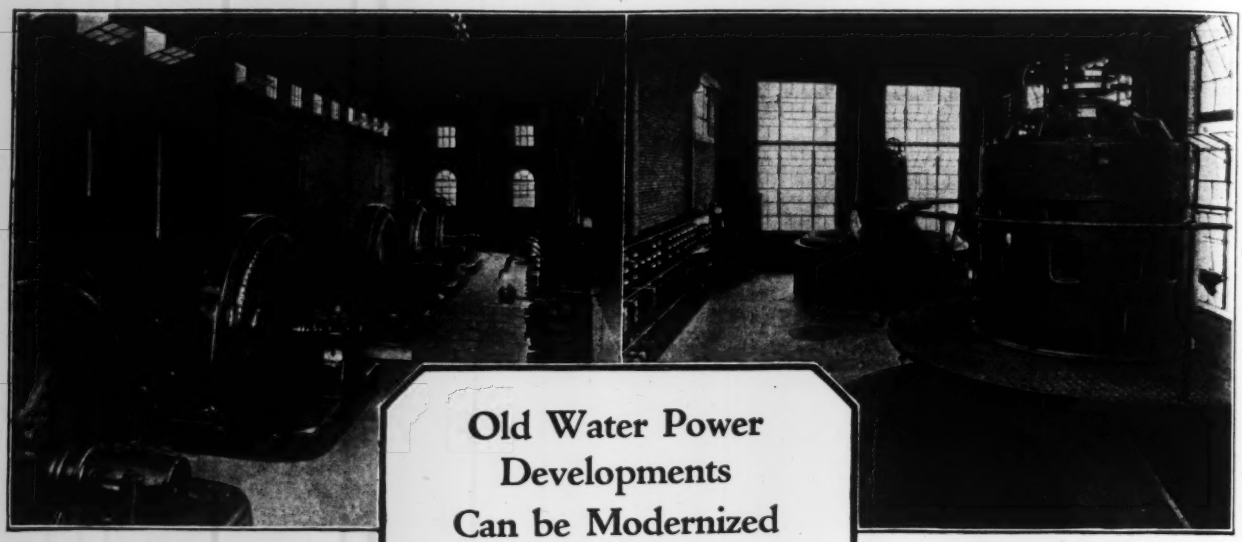

BEFORE RECONSTRUCTION
4800 K.W.

Old Water Power Developments Can be Modernized with Profit

AFTER RECONSTRUCTION
7200 K.W.

BY redevelopment of existing water power plants, our engineers have assisted the Manchester Traction, Light and Power Company in substantially increasing generating capacities and plant efficiencies. The capacity of one plant was increased from 4800 kw. to 7200 kw. with an increase of 25% in plant efficiency. In another plant the efficiency was increased 50%.

The opportunity to utilize interconnected water power to carry the peak load of steam plants demands that the reconstruction of old water power plants receive the closest study. Our engineers are prepared to assist all such investigations.

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A Form For Every Pile

A Pile For Every Purpose

Note the concrete section is poured into a spirally reinforced steel shell left in the ground.

In Composite Piles, the BOND is everything. The Raymond method preserves virtually the full strength of timber and concrete and insures exact alignment of the finished pile.

RAYMOND CONCRETE PILE COMPANY

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RAYMOND

A Faster—Cheaper —Easier Way to Hang Light Loads

EVERY contractor should get to know this Kalman Hanger Insert. It makes the hanging of light loads from floor slabs a faster, cheaper, and easier job. Setting is simple. Just push the insert into place on the forms—give it a blow or two with a hammer—and it is in for the life of the building.

No nails are needed—and setting time is often reduced to about half that required for ordinary inserts. When the forms are taken down there is no more work to be done—no staples to clip, except where unusual appearance is desired, and no time is wasted in fishing inside for the fastening. A wire ring—or a strap hanger—immediately drops from the insert to below the ceiling level.

Hanging rods or wires can be attached quickly and easily. If you will mail us your name and address we'll send you our Kalman Hanger Insert folder. You can see for yourself how it can save you time, money, and labor.

KALMAN STEEL COMPANY, 1452 Wrigley Bldg., Chicago

KALMAN STEEL

FOR BUILDINGS
Corrugated Bars
Column Spirals
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Read What R. G. Houser Says

You can get performance like this, too, if you put a Bear Cat on the job

Brown Bevis Company,
Los Angeles, California

Sept. 1, 1926

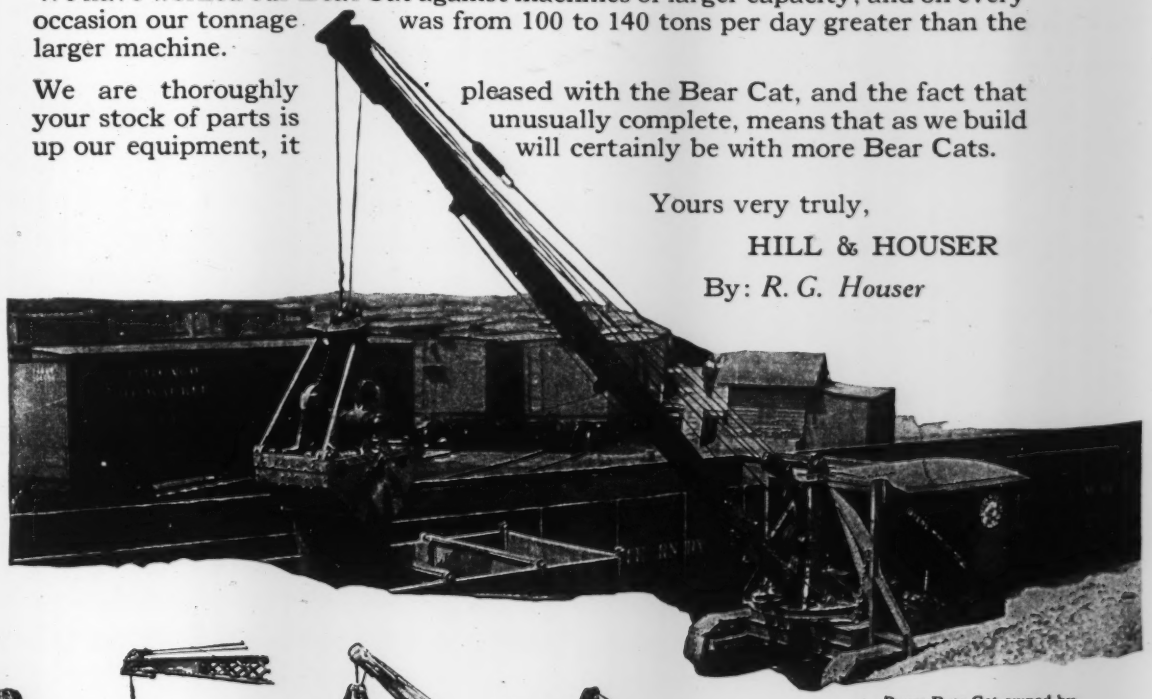
Gentlemen:—

We are getting about 8 cars per 9-hour day with our Bear Cat machine,and on one job where we were loaded up with cars, we unloaded 17 cars per day for 14 successive days. The crane on this job worked from 5 A.M. until 8 P.M. each day.

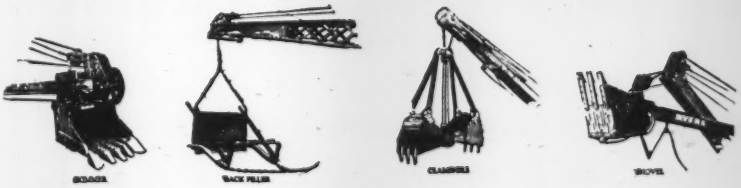
We have worked our Bear Cat against machines of larger capacity, and on every occasion our tonnage was from 100 to 140 tons per day greater than the larger machine.

We are thoroughly pleased with the Bear Cat, and the fact that your stock of parts is unusually complete, means that as we build up our equipment, it will certainly be with more Bear Cats.

Yours very truly,
HILL & HOUSER
By: *R. G. Houser*



Byers Bear Cat owned by
Julius Brasch, Chicago, Ill.



The Bear Cat handles all these interchangeable attachments, one man operated, for grading, ditching, excavating, backfilling, etc. Send for complete Catalog.

THE BYERS MACHINE COMPANY, Ravenna, Ohio

Builders also of Byers Truckrane
Sales and Service Throughout the Country

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State ..... E.N.R. 9-30-26

50 ERIES making money for Buffalo contractors

The John W. Cowper Co. is particularly pleased with this ERIE Crane, and no wonder— it went in to replace a gas crane that was making trouble, and gave them "ERIE reliability" instead.

"She's wonderful!" is the way Reimann & Hummel size up this B-2 ERIE Dreadnaught, that loaded out 3855 yards of the Rogers-Brown Iron Company's slag in 6 days and 5 hours actual working time.

"A better money maker and a safer investment than the best of bonds," says Col. Horton. The D. E. Horton Construction Co. reports "No lost time— upkeep cost less than $50 for 2 years — the excellent service this ERIE has given has convinced us that it is the best machine on the market." They have 2 ERIES now.

"What! A 1-yd. whirley handle work like this?"

It sure looked like a place to use big railroad shovels—the Bethlehem Steel Co. job, with 200,000 yds. of the toughest slag you ever saw, to say nothing of the old concrete and scrap iron.

And some of the boys in Buffalo laughed at the idea of any 1-yd. whirley doing it— until Gallagher & Kohler knocked out over a thousand yards in one day with one of their B-2 Steam ERIES.

(A good deal of shooting had to be done on account of the solid concrete wall you can see at the right, in the above picture.)

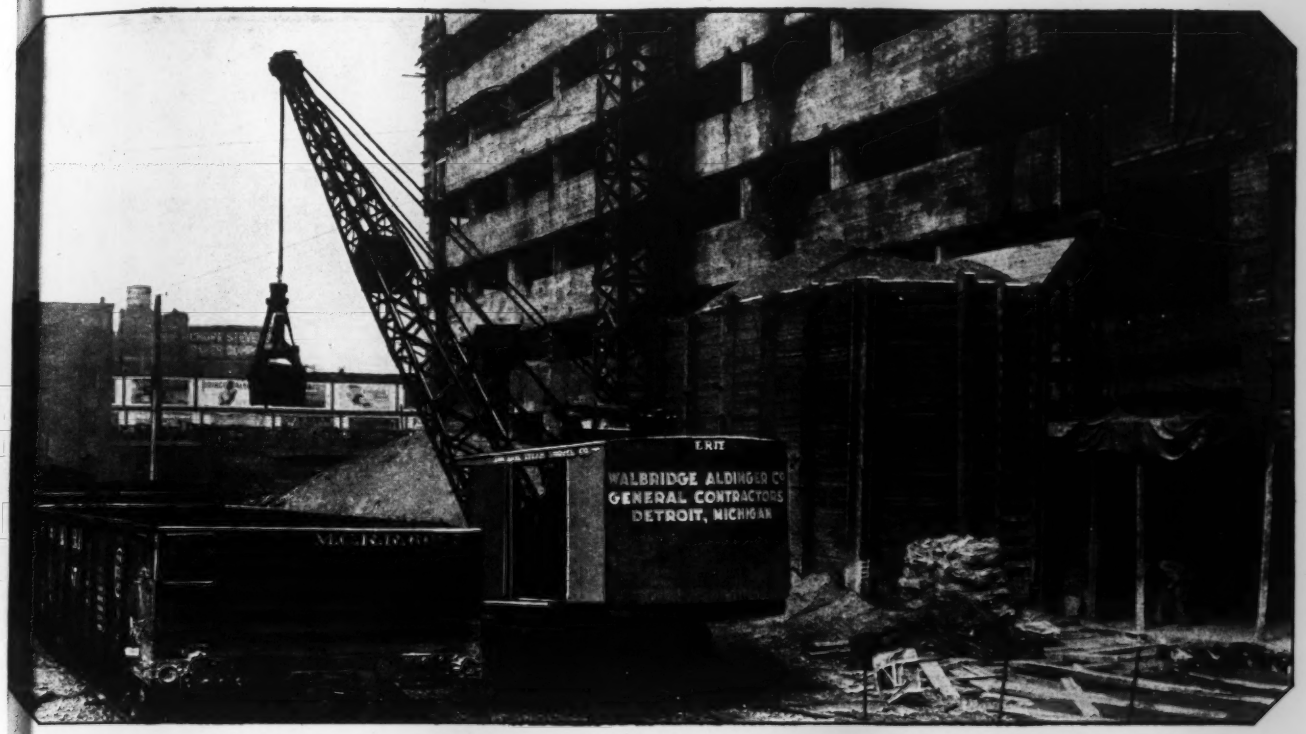
One 10-hour day a B-2 ERIE loaded 22 of the 50-yard cars shown here. No wonder John Gallagher says: "I've run them all and there's nothing like an ERIE."

Only ERIES on this rush job— 5 of them, all told.

Buffalo contractors put *reliability* first when buying a shovel— and have bought 50 ERIES. They know the value of a real 3-engine shovel that can give a big output in hard digging— and keep on doing it.

ERIE STEAM SHOVEL CO., Erie, Pa., U.S.A.
Branch Offices: Boston, New York, Philadelphia, Pittsburgh, Atlanta, Chicago
Representatives throughout the U. S. A.

ERIE Steam DREADNAUGHT Shovel and Crane



Walbridge, Aldinger Company

The well-known Detroit contractors, write that

"This Gas+Air ERIE has given us good satisfaction with low upkeep"—

And so far, it has been used only as a crane for unloading gravel from cars, and keeping bins full.

After Walbridge, Aldinger Company have had a chance to work this machine as a shovel, they will see how completely it eclipses other Gasoline Shovels.

Here's the kind of letter that's written by the contractor who had done both crane and shovel work with the Gas+Air ERIE:

"The Gas+Air ERIE is much faster than any other machine I have seen at work, and is much easier to operate.

"This machine worked fine as a shovel taking out stumps. Now we have it converted to a clamshell crane, building dykes with fine success.

"Our upkeep has been very low, and the Gas+Air ERIE is absolutely reliable."—*James R. McCordic, McCordic Construction Co., St. Petersburg, Fla.*

AN UNBEATABLE COMBINATION is what the buyer of a Gas+Air ERIE gets—

(1) He has a gasoline crane with a quick, smooth swing—a *cushioned* swing like a steam crane's—

(2) And when he changes over to shovel work, he has *a real 3-engine shovel* that has no rival among other gasoline shovels—and in fact holds up its end against steam competition.

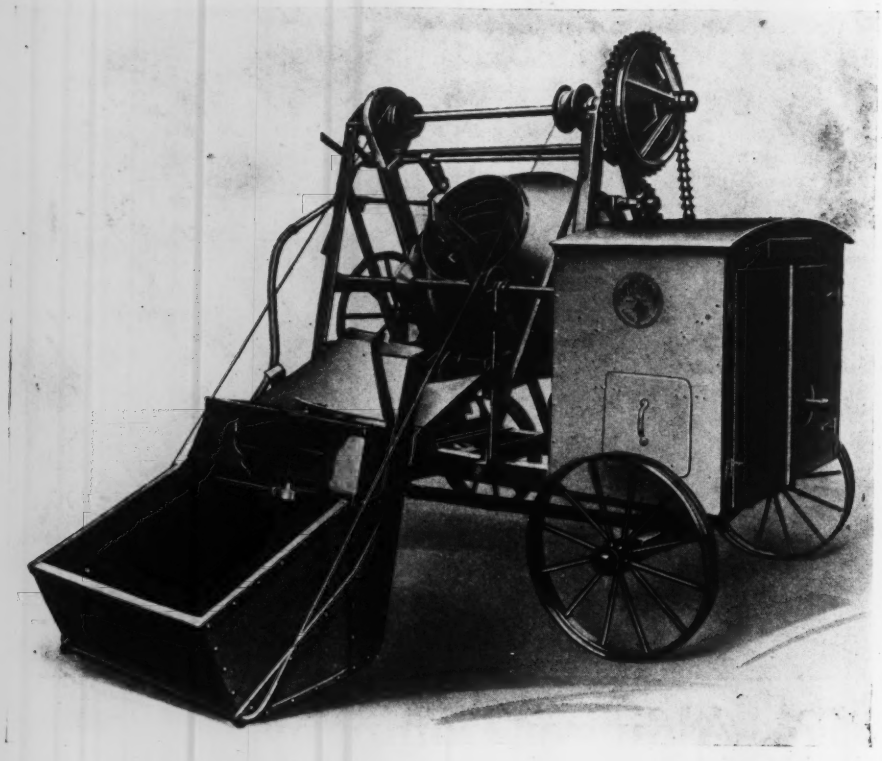
You get all the conveniences of gasoline fueling, combined with the *speed* and *flexibility* of a Steam ERIE.

ERIE STEAM SHOVEL CO., Erie, Pa., U. S. A.

Builders of ERIE Shovels, Cranes, Ditchers, Draglines, Trench Hoes, etc.

ERIE GAS+AIR Shovel and Crane

Fully protected by basic patents



No. 5-S Tilting Mixer

— on trucks, with power loader and unit automatic water tank.

There's never been anything like it—

That genuinely automatic water tank built into the Power Loader of this 5-S mixer is certainly one more big improvement that will stand in mixer history to Ransome's credit.

Get this right—that tank is absolutely automatic. Once the hose is connected to your water supply and the float set for the desired amount of water per batch, it doesn't require further attention. There isn't even any lever to pull. The water flows into the drum by gravity—and just an instant ahead of the dry aggregates.

You should have the whole story of this new Ransome mixer—that automatic unit water tank is only one of several features. Send for Bulletin No. 117-A.

Ransome Concrete Machinery Co.

Dunellen, New Jersey

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272

LAKEWOOD CONCRETE PLACING EQUIPMENT

A Recognized
Leader throughout
The World
September 9, 1926
ENGINEERING NEWS-RECORD
411
FIG. 1—SCHRAHN DAM SITE AT BEGINNING OF WORK
View looking northeast.
FIG. 2—SCHRAHN DAM DURING CONSTRUCTION
View looking southwest; mixer plant and conveying tower at right.
FIG. 3—SCHRAHN DAM, LOOKING HOPPER OF AERIAL CABLEWAY DISTRIBUTING CONCRETE
FIG. 4—SCHRAHN DAM NEARLY COMPLETED
End tower of aerial cableway at extreme right.

IN SWITZERLAND

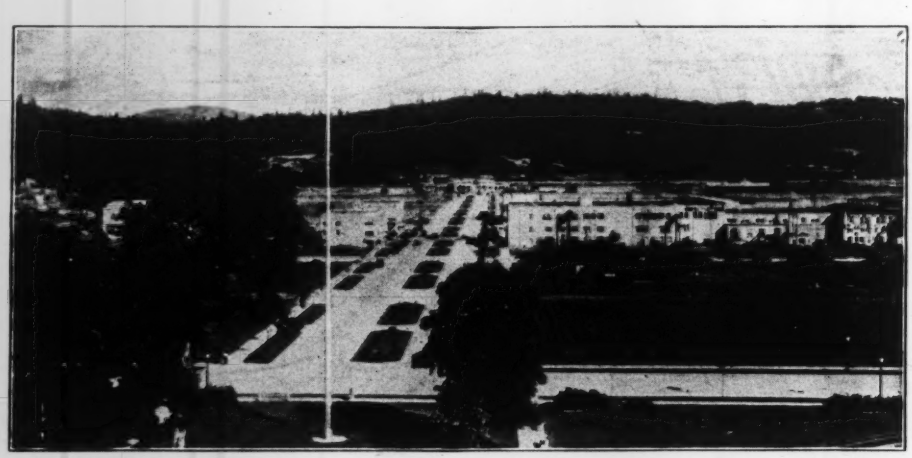
Lakewood Mixers, Steel Towers and Arched Band Chuting Equipment handled the concrete on the Waeggithal Power Development as described in Engineering News-Record, Sept. 9th, 1926.

For details write for Bulletin 23-R

THE LAKEWOOD ENGINEERING COMPANY

Cleveland, Ohio

Export Office: 30 Church St., New York City **Cable Bro-sites**



Longview, Washington, has 800,000 square yards of Concrete Streets

Concrete streets *paved the way*

HUNDREDS of cities have found concrete streets one of the best investments they ever made. An outstanding example is Longview, Washington.

Three years ago the site of Longview was only farm and grazing land. Today it is a model city of industries and homes.

Concrete streets played an important part in this development.

Longview, with 10,500 population, now has 800,000 square yards of concrete streets. And finer looking streets you have never seen. They are true and even; absolutely free of bumps and ruts.

They are always safe to drive on, wet or dry. And they cost practically nothing to maintain.

More and more, municipal officials are making their reputations secure by building concrete streets.

The Portland Cement Association has a personal service to offer individuals or communities. Just write the nearest office listed below. There is no obligation

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A National Organization to Improve and Extend the Uses of Concrete

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Steelcrete
CONCRETE REINFORCEMENT

CURVED slabs, only two inches thick, precast on the job, used as permanent forms over the air duct of the Hudson River Vehicular Tunnel. Slabs are reinforced with Steelcrete Mesh, cut to size at our mill. They saved labor, speeded the work.

Steelcrete
TRADE MARK REGISTERED

CONCRETE
REINFORCEMENT

Precast—for the Hudson River Vehicular Tunnel

THE "TIME-TESTED" REINFORCEMENT

MORE than 118,000 sq. ft. of Steelcrete Mesh, and over three miles of Steelcrete Beam Wrapper, are installed in this great piece of engineering work.

Precast concrete slabs, 4′2″x2′0″x2″, thousands of them, poured on the job, were used as permanent forms for the concrete roof of the air ducts. The reinforcement is Steelcrete Mesh—cut to size at our mill.

Here again on this job Steelcrete Mesh solved the problem. It gave the necessary strength to the slabs. Curved to shape it was readily put in position in these thin 2-inch slabs. And Steelcrete Mesh, ready cut to size, saved time.

On your next job see what you can save, what you can gain, by the use of Steelcrete Mesh — the adaptable reinforcement. Let us work on your problem. Our ideas are yours for the asking.

Structural Engineers
ATTENTION

Get the data on design of bank vaults. A new principle of protection, a new problem in structural design.

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Foreign Sales Office: 152 West 42nd St., New York City

Please send Steelcrete catalogue and free sample of 3-9-20 Steelcrete Mesh as used in the Holland Tunnel.

Firm.....

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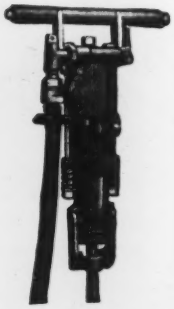
Name.....



CP-10 Rock Drill

CP-8 and CP-10 Rock Drills are light, powerful sinkers designed and built to give maximum footage with low air consumption and extremely low cost of maintenance.

BQ-46 Demolition Tool

The BQ-46 is especially adapted for construction repair work, combining a concrete breaker, asphalt cutter, backfill tamper and rock drill in one.

Profit or Loss?

EXPERIENCE has demonstrated to successful contractors that satisfactory profits can only be secured by the use of equipment guaranteeing speed in completion of work with lowest costs of operation and maintenance.

Through fulfilling these requirements, CP products have been adopted to a very great extent.

Boyer Rammers are extensively used for tamping backfill. The complete protection afforded all working parts against excessive damage by sand insures long life and minimum upkeep expense. Boyer tamped backfill does not rut or settle.

Boyer Clay Diggers loosen hard clay and other material too stubborn for pick and shovel methods, yet not hard enough for drilling and blasting.

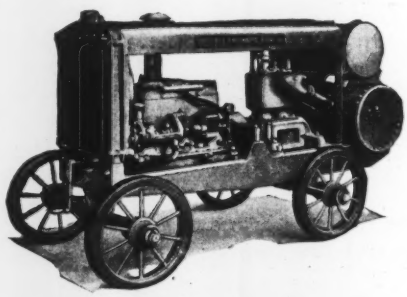
Chicago Pneumatic Portable and Stationary Compressors are supplied in steam, oil, belt and direct motor driven types to meet all compressed air requirements.

CP Equipment will speed up your contracts and reduce your labor costs. Let us give you a demonstration under your own working conditions.

After all, what users say counts most.

"As you know, we did not purchase any of this equipment (CP-10 Rock Drills and BQ-46 Demolition Tools) until we had made a thorough trial of other makes of drills, and we made our purchase from you as we found that your equipment suited us better than any other for this type of material."

Photostat copy of letter on request.



Chicago Pneumatic Portable Compressor on rubber-tired wheels. Also supplied on steel wheels, or on skids.

J-251

CHICAGO PNEUMATIC

Chicago Pneumatic Tool Co.

Sales and Service Branches All Over the World

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CHICAGO PNEUMATIC

PARSONS

THE BEST TRENCH EXCAVATOR

"We appreciate the way you keep in touch with your equipment"

Whether he is buying a good automobile, a trench excavator or any other equipment, the modern man takes the question of "service" carefully into consideration.

Here is what O'Brien & Halloran, Contractors of Lima, Ohio, say about Parsons trench excavators and Parsons service:

"The Parsons Trench Machine which we purchased from you last spring has completed upward of 15 miles of trench work running in depth from six to ten feet.

"Performance of the machine has fulfilled in every way the recommendations you placed on it and we are highly pleased in the satisfaction the Parsons has given us, as well as with the splendid service and methods that have existed in our dealings with The Parsons Company.

"Your keeping in touch with your equipment while it is on the job has been a real service to us, and consequently our trenching is pursued with entire confidence."

THE PARSONS COMPANY

Newton, Iowa, U. S. A.

Chicago: 11 So. La Salle St. **Los Angeles: C. C. Sixbey, 677 Chamber of Commerce Bldg.** **New York: 501 Fifth Avenue**

PICK A PARSONS *and* QUIT PICKING

WESTERN-INTERNATIONAL
POWER MAINTAINERS

THE popular Aurora Standard and Little Western Graders can now be operated, in combination with an international 10-20 Tractor, as single motorized units. The tractor is very easily detached so that it is always available for other purposes.

Tractor pulls instead of pushes

One of the outstanding features of this combination is that the tractor pulls instead of pushes the blade, thus enabling the weight of the tractor to overcome the side draft on the blade and hold it to straight course.

Other advantages

The blade-lifting control has a machine-cut worm and gear which eliminates lost motion and is self-locking. These outfits do not need any more room to turn around in than the tractor itself and are steered as easily as a high-powered automobile—Timken Tapered Roller Bearings and large rubber-tired rear wheels add much to the smoothness of the work.

A special bulletin describes these machines in detail. Write for your copy today.

The Austin-Western Road Machinery Co.

400 North Michigan Ave. **Chicago, Ill., U. S. A.**

A Consistent Performer

LINK-BELT Crawlers are consistently reliable—they give that "new crane" performance year after year, unlike cranes that have lost their snap and "new crane" efficiency.

ON CHICAGO'S Lake Front, excavating for the Illinois Central Railroad's new electrification project, where speed and consistent performance is essential, this Link-Belt Crawler is in continuous operation.

The Link-Belt Crawler can be equipped with dipper shovel, trench shovel, drag-line bucket, grab bucket, skimmer scoop, and all other improved attachments.

Catalog No. 895 will be gladly sent on request. 2722

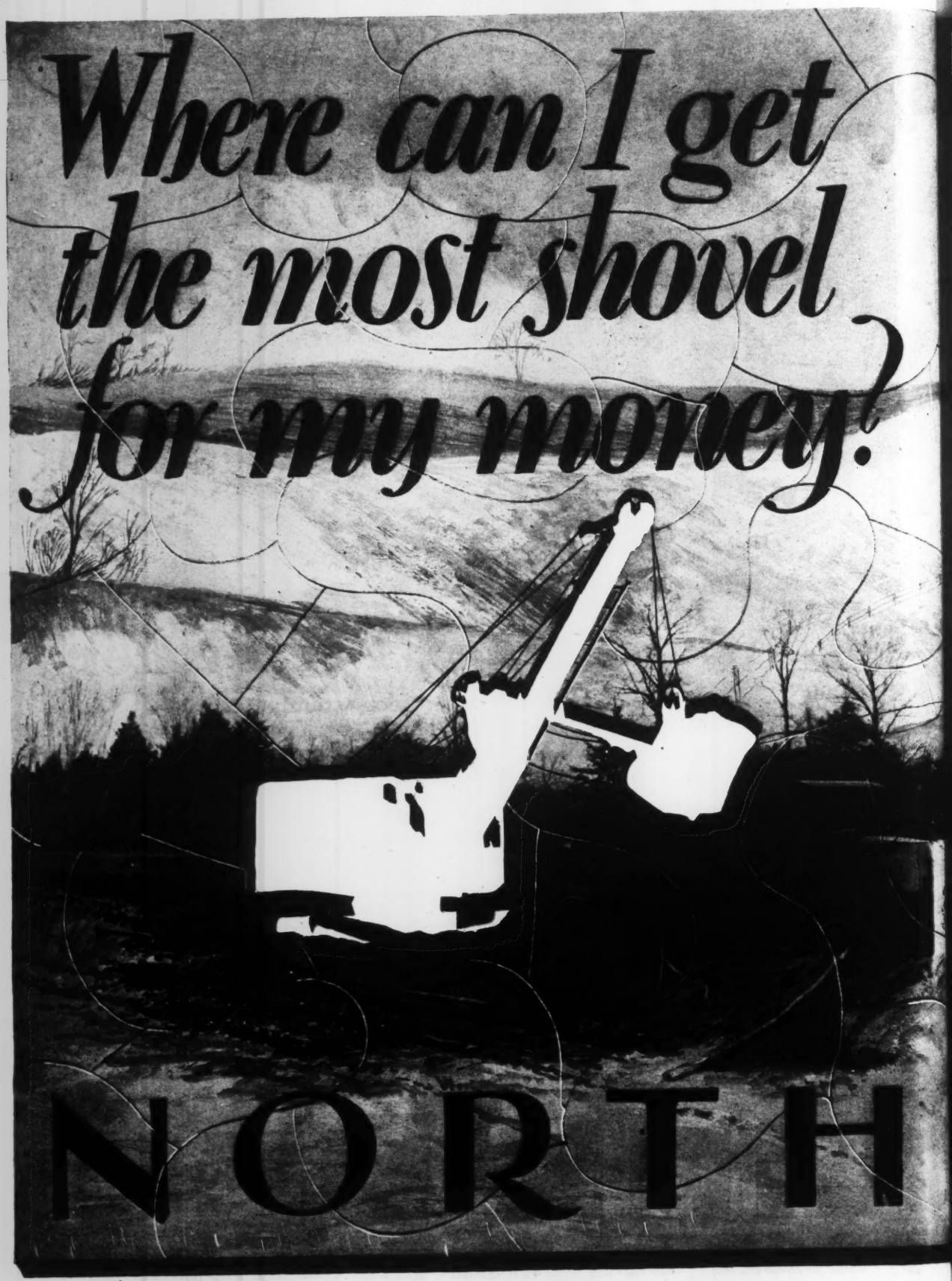
LINK-BELT COMPANY

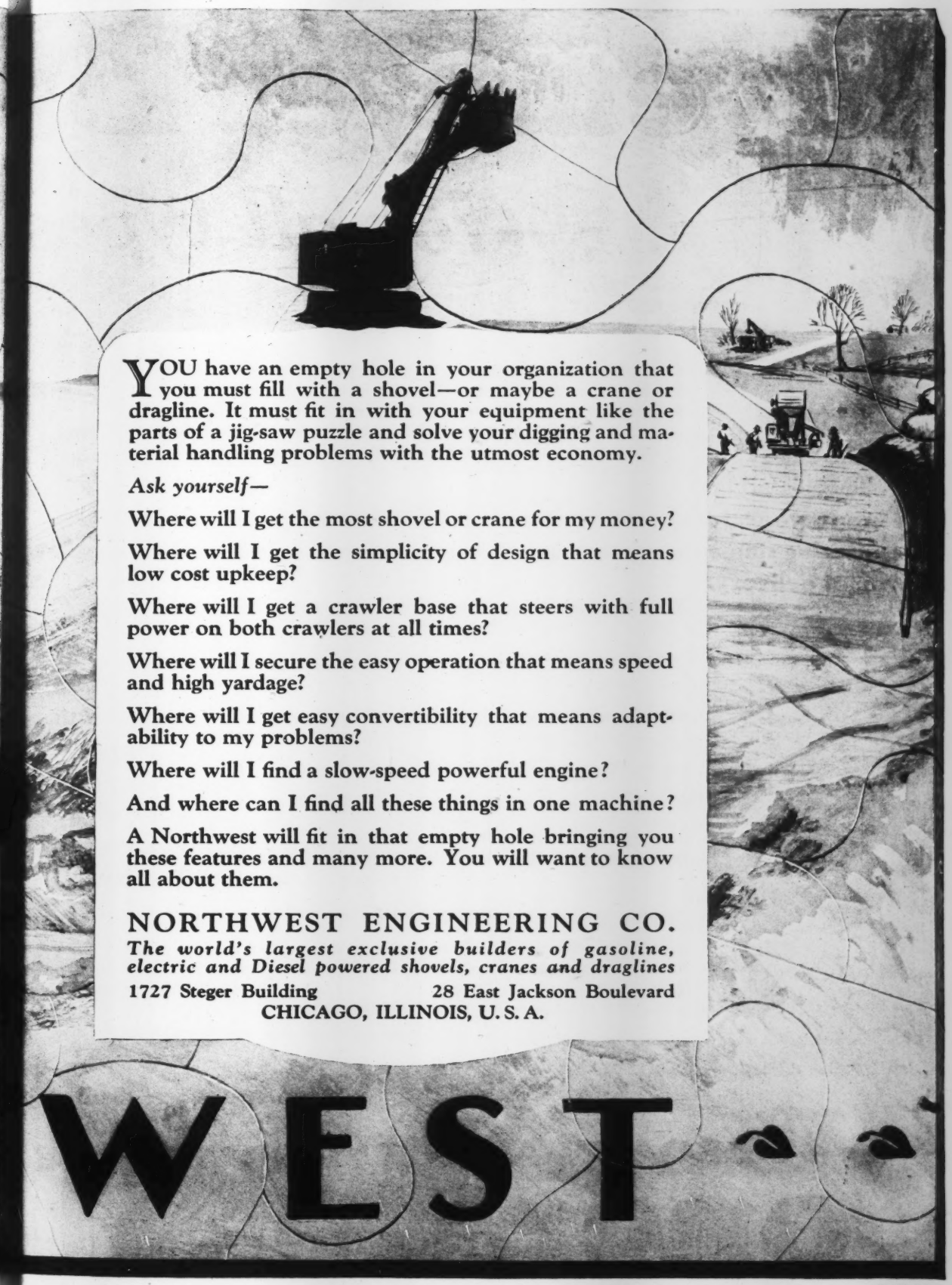
Leading Manufacturers of Elevating, Conveying and Power Transmission Machinery

CHICAGO, 300 W. Pershing Road Offices in Principal Cities

LINK-BELT

"Built for Service" Crawler


Where can I get
the most shovel
for my money?
NORTH



YOU have an empty hole in your organization that you must fill with a shovel—or maybe a crane or dragline. It must fit in with your equipment like the parts of a jig-saw puzzle and solve your digging and material handling problems with the utmost economy.

Ask yourself—

Where will I get the most shovel or crane for my money?

Where will I get the simplicity of design that means low cost upkeep?

Where will I get a crawler base that steers with full power on both crawlers at all times?

Where will I secure the easy operation that means speed and high yardage?

Where will I get easy convertibility that means adaptability to my problems?

Where will I find a slow-speed powerful engine?

And where can I find all these things in one machine?

A Northwest will fit in that empty hole bringing you these features and many more. You will want to know all about them.

NORTHWEST ENGINEERING CO.

The world's largest exclusive builders of gasoline, electric and Diesel powered shovels, cranes and draglines

1727 Steger Building 28 East Jackson Boulevard

CHICAGO, ILLINOIS, U. S. A.

ENR9-30 Gray

Havemeyer Bu

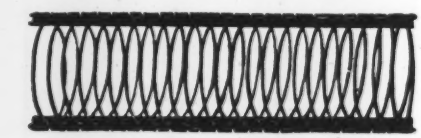
for all types

Havemeyer Bars

Delivered bent, cut, fabricated, tagged, all ready to place in the forms. There's a Havemeyer warehouse near your job, with large stocks, insuring immediate shipment and prompt delivery.

Spirals

Made and assembled in our own shops, with two spacers (more if desired). Shipped compactly, collapsed, ready to set in forms when opened; require no straightening. Strong. Rigid. Large stocks, prompt shipment.



42 BROADWAY, NEW YORK SALE

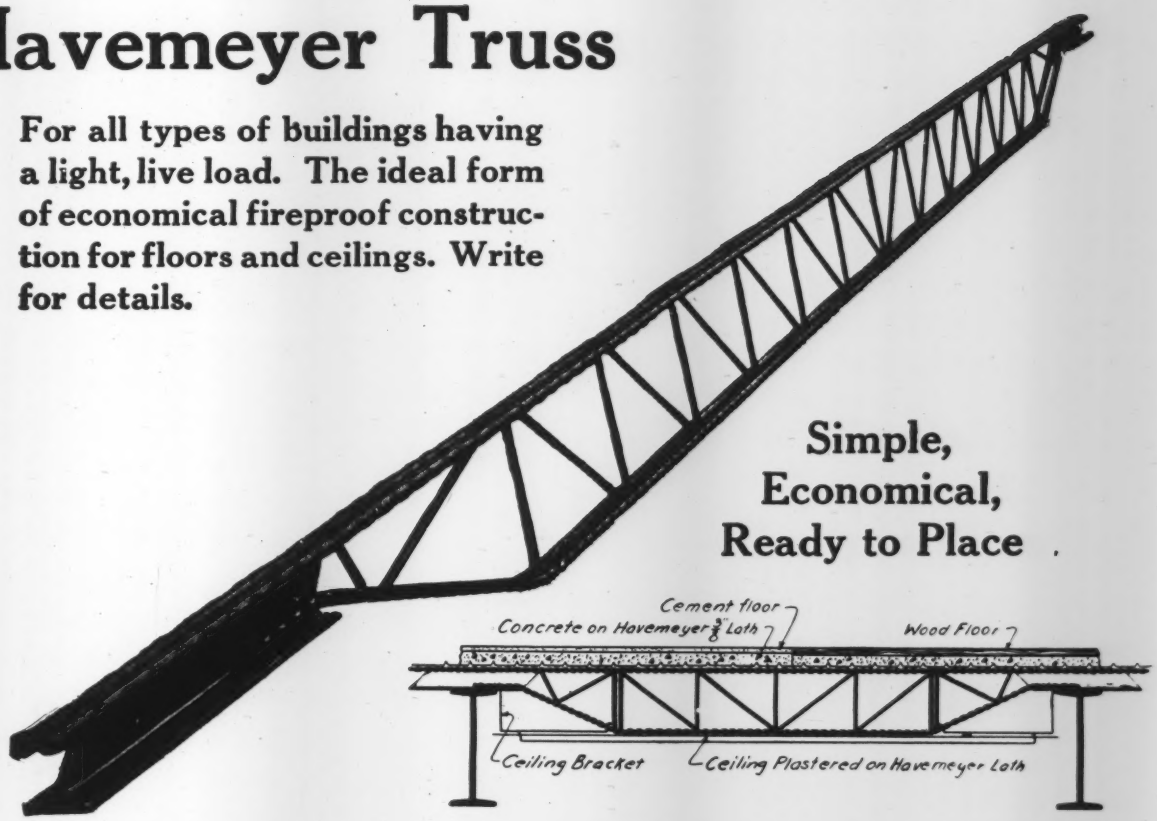
Concrete St

ulding Products

s *of construction*

Havemeyer Truss

For all types of buildings having a light, live load. The ideal form of economical fireproof construction for floors and ceilings. Write for details.



Simple, Economical, Ready to Place

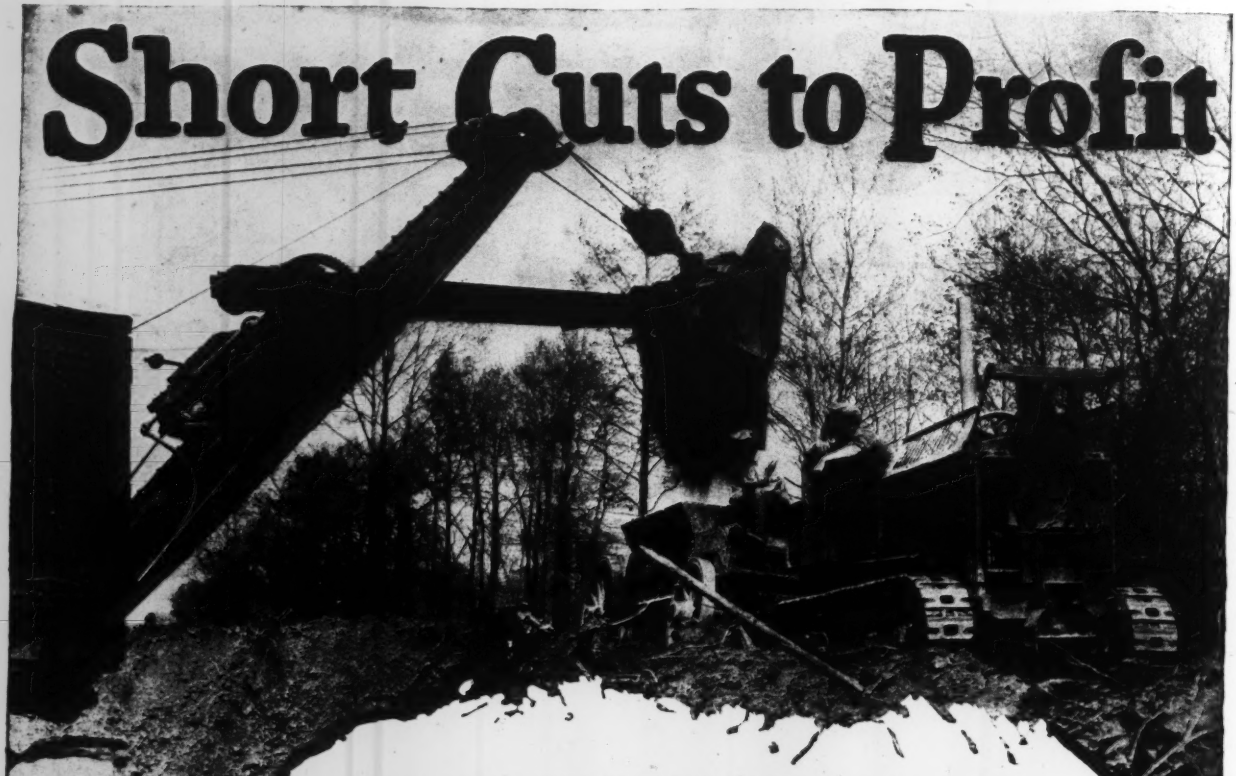
Diagram above shows typical floor and ceiling construction with Havemeyer Truss. Can be used either on steel beams or masonary walls. Standard units, spans 4 ft. to 31 ft. Delivered ready to place. Large stocks for immediate shipment.

Truss Plant: AKRON, OHIO

LE OFFICES & WAREHOUSES IN PRINCIPAL CITIES

eel Company

Short Cuts to Profit



"CATERPILLAR" TRACTORS

supply the power and traction for the many "short cuts" of resourceful earth-movers!

Working in untavorable weather is a short cut —so is a double shift when time is short. New uses and new adaptations reduce time—so do heavier tools that make the most of "Caterpillar" ruggedness.

"Caterpillar" equipment arms your ingenuity with the tools for cost-cutting and profit-making!

There is a "Caterpillar" dealer near you

"Caterpillar" Prices

2-TON (*Peoria, Illinois*)	$1850
THIRTY (*San Leandro, California*)	$3000
5-TON (*Peoria, Illinois*)	$3250
SIXTY (*San Leandro or Peoria*)	$5000

CATERPILLAR TRACTOR CO.

Executive Offices: San Leandro, California, U. S. A.
Factories: Peoria, Illinois - San Leandro, California
New York Office: 50 Church Street

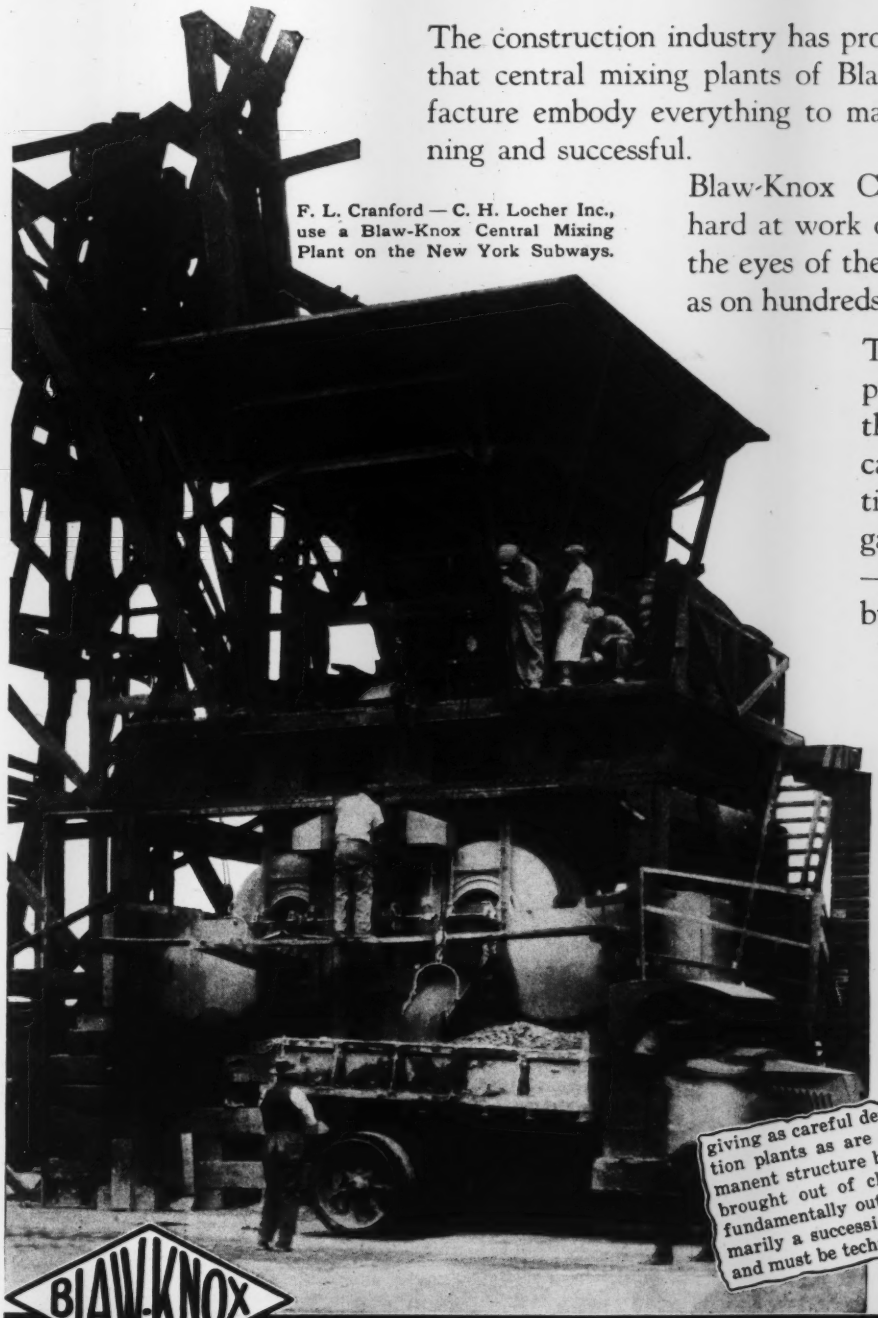
Successor to
BEST C. L. Best Tractor Co. — The Holt Manufacturing Company HOLT

76-926

BETTER · QUICKER · CHEAPER

CATERPILLAR
REG. U.S. PAT. OFF.

Designing *Central Mixing Plants* is a BLAW-KNOX Responsibility



F. L. Cranford — C. H. Locher Inc., use a Blaw-Knox Central Mixing Plant on the New York Subways.

The construction industry has proven to its own satisfaction that central mixing plants of Blaw-Knox design and manufacture embody everything to make concreting smooth-running and successful.

Blaw-Knox Central Mixing Plants are hard at work on many jobs prominent in the eyes of the engineering world, as well as on hundreds of smaller jobs.

They are designed for the particular characteristics of the job; whether the specifications call for the proportioning of concrete aggregates by volume or by weight —or for constant concrete by the Inundation System.

Ask Blaw-Knox about Central Mixing Plants

BLAW-KNOX CO.
601 Farmers' Bank Bldg.
Pittsburgh, Pa.

New York—30 E. 42nd St.
Chicago—Peoples Gas Bldg.
Detroit—Lincoln Bldg.
Cleveland—Union Bldg.
Baltimore—Bayard & Warner Sts.
Birmingham—Brown-Marx Bldg.
Buffalo—Genesee Bldg.
Philadelphia—Colonial Trust Bldg.

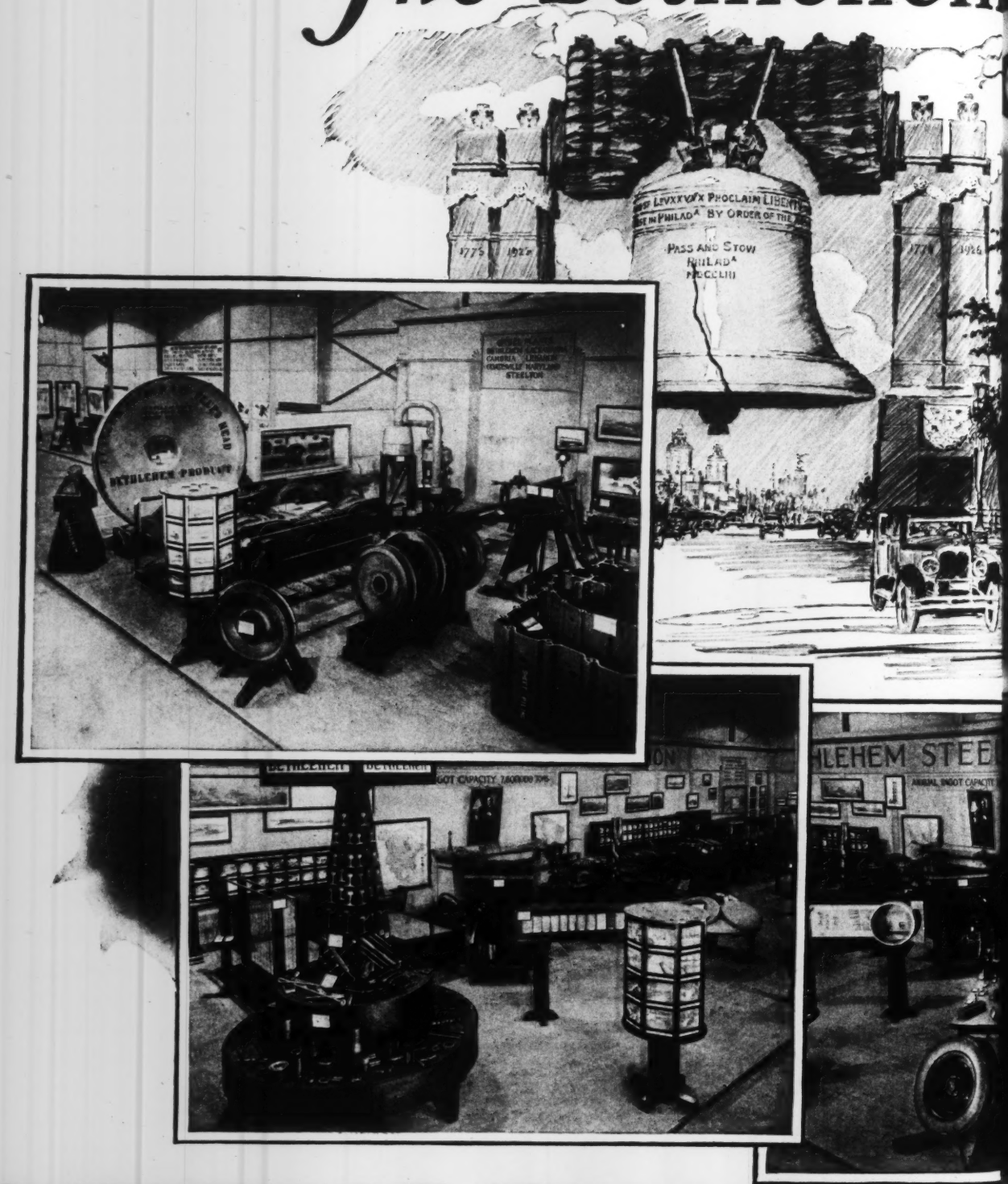
Skilled contractors today are giving as careful design thought to temporary construction plants as are the directing engineers to the permanent structure being built. This condition has been brought out of close competition for work but more fundamentally out of the fact that construction is primarily a succession of co-ordinated machine operations and must be technically planned and directed.

Editorial from Aug. 5th, 1926, issue of Engineering News-Record.

BLAW-KNOX

BLAW-KNOX

The Bethlehem



BETHLEHEM

Exhibit at the Sesqui-Centennial Exposition

WE CORDIALLY invite you to visit our exhibit in the Mines, Metallurgical and Transportation Building at the Sesqui-Centennial Exposition in Philadelphia. We have endeavored to make our display one that will be of interest to those associated with the iron and steel and allied industries, and to users of iron and steel products, and at the same time of educational value to visitors in general.

Our display includes not only a great diversity of rolled steel products but also examples of various types of special machinery and equipment manufactured by Bethlehem, as well as photographic views of manufacturing operations and processes.

A visit to our exhibit offers a fine opportunity to obtain a definite idea of the great variety of products manufactured by Bethlehem Steel Corporation.

Our representatives will take pleasure in giving you any information desired.

BETHLEHEM STEEL COMPANY
General Offices: BETHLEHEM, PA.

District Offices: New York Boston Philadelphia Baltimore Washington Atlanta Pittsburgh Buffalo Cleveland Detroit Cincinnati Chicago St. Louis San Francisco Los Angeles Seattle Portland

Bethlehem Steel Export Corporation, 25 Broadway, New York City
Sole Exporter of our Commercial Products

BETHLEHEM

Masterbuilt Floors

HARDENED DUST-PROOF CONCRETE

Eight Years Without a Jar

THERE is very little difference between the initial cost of a Masterbuilt concrete floor and an ordinary concrete floor. The important difference in cost comes after a few years when the plain floor begins to show the wrinkles of age, and then you pay, and pay, and pay.

For example, eight years ago, this Masterbuilt Floor was laid in the Bridgeton, New Jersey plant of the Illinois Glass Company in areas subjected to their heaviest trucking. It was vitally important that the new concrete surface should remain perfectly smooth, hard and dustproof, because jarring and jolting over a rough or dusting cement floor would ruin the newly cast glass products.

Without interruptions by floor troubles or floor repair operations, the procession has moved steadily ever since. Today the surface is hard, smooth, and dustproof as it was in the beginning and gives every evidence of remaining so for another decade.

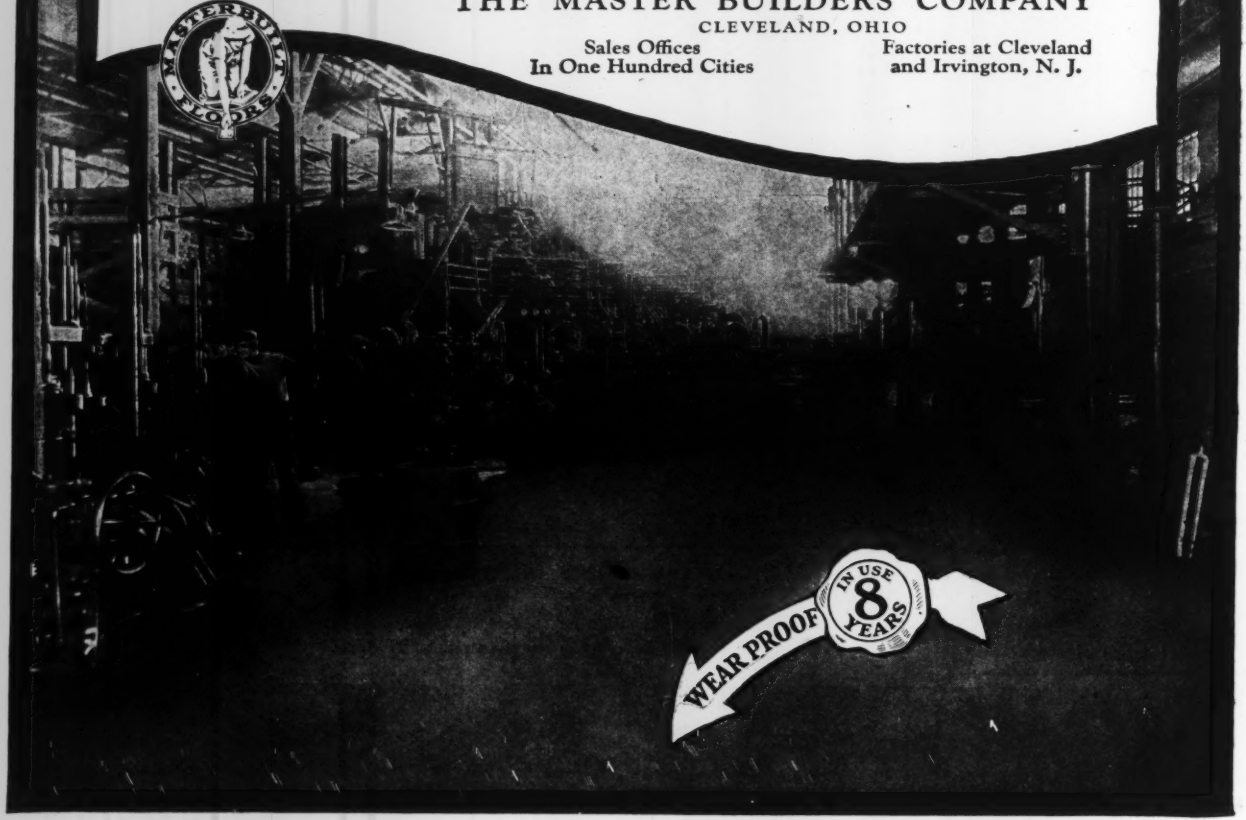
Write floor insurance of this character for your plant or your clients by specifying "All concrete floors shall be Masterbuilt."

The firing room of The Illinois Glass Company's Bridgeton, N. J., plant, where a Masterbuilt Floor has remained smooth, hard and dustproof during eight years of heavy trucking.

THE MASTER BUILDERS COMPANY
CLEVELAND, OHIO

Sales Offices
In One Hundred Cities

Factories at Cleveland
and Irvington, N. J.

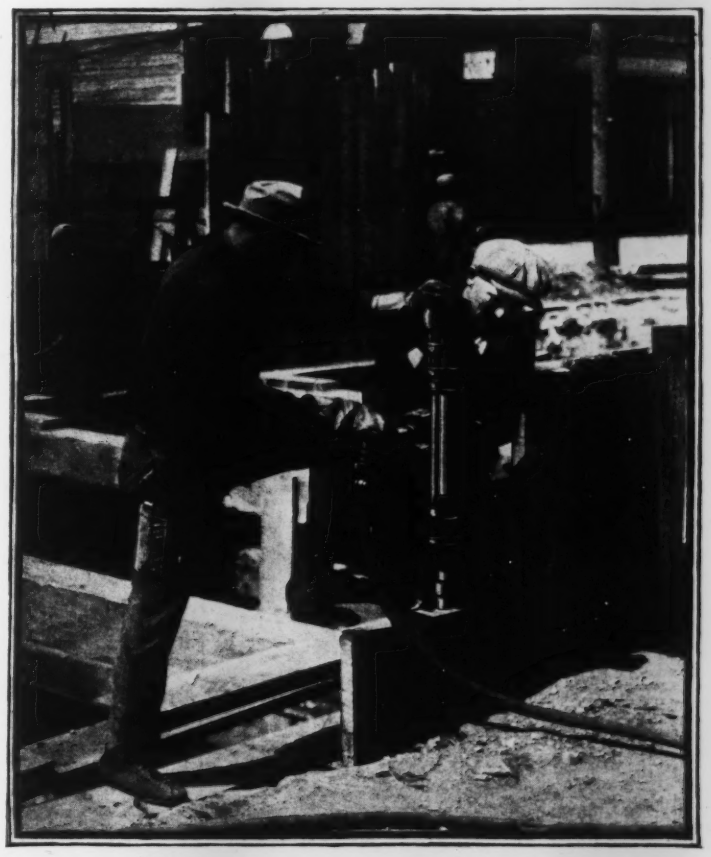


Don't study these figures!

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
				Common Labor					
Common labor, union, hour....	.90⅝	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour.	.....	.25	.30@.50	.82½	.45@.60	.40@.45	.50	.50	.30@.35

—there's a cheaper way to drive!

You can drive light timber and steel sheeting far more quickly and economically with a McKiernan-Terry "Labor Saver" (No. 1, 2 or 3) than with common hand labor. So why study cost figures? Just let us tell you a *few* instances of the many in which these smaller McKiernan-Terry's have saved time and money for contractors, here and abroad.



Now write for Bulletin 35. Tells and shows all you want to know about the full line of McKiernan-Terry Hammers.

McKIERNAN-TERRY DRILL COMPANY
Pile Hammers—Lifting Jacks
13 PARK ROW, NEW YORK **Works at Dover, N. J.**

Agencies in the following cities:
Boston, Chicago, Pittsburgh, Cleveland, Detroit, St. Paul, San Francisco Columbus, O., New Orleans, Philadelphia, Portland, Ore., Jacksonville, Fla., Houston, Texas, Los Angeles, Calif.

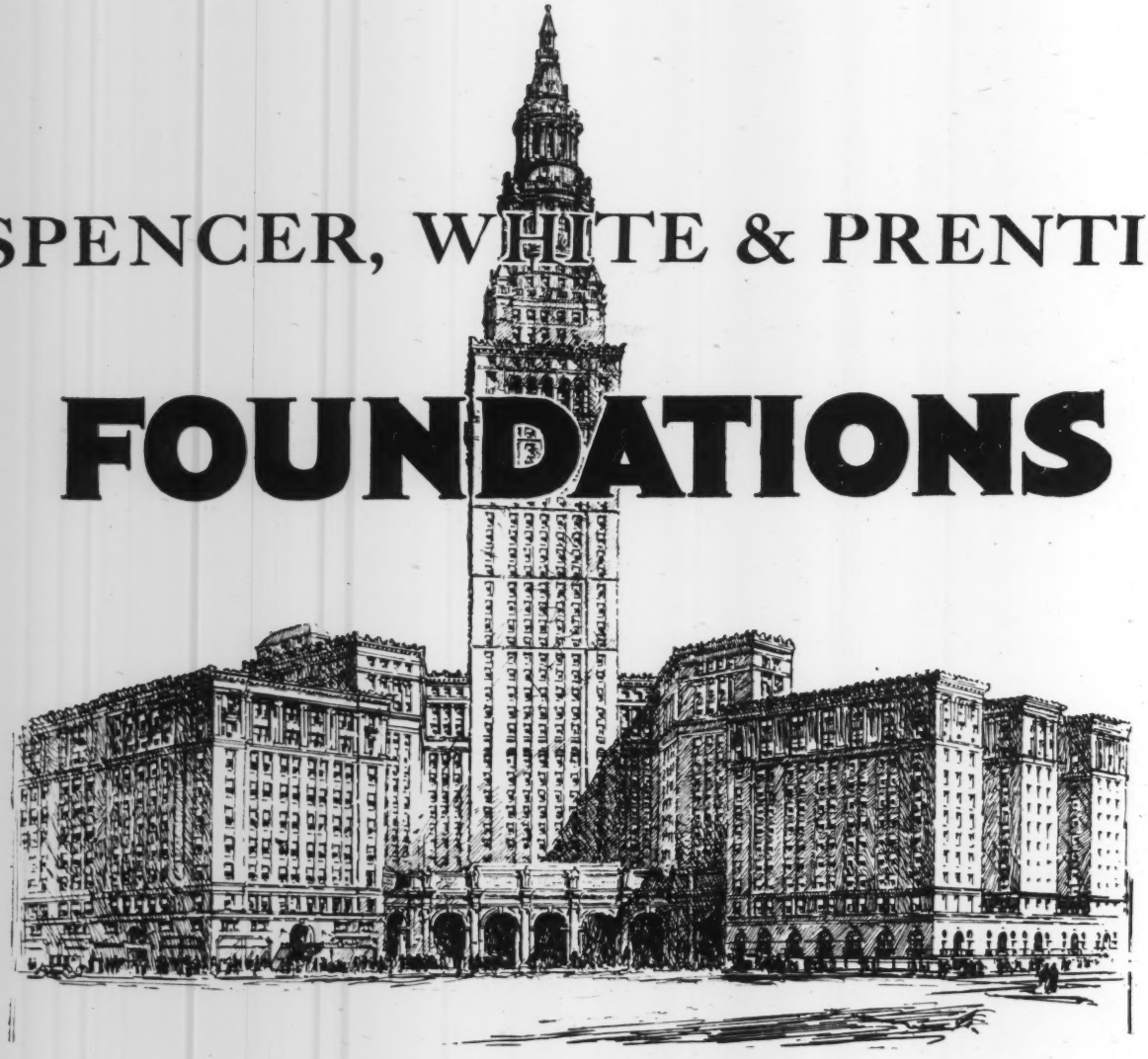
Foreign Representatives: British Steel Piling Co., London, England

McKIERNAN-TERRY
The Pioneer Double-Acting Pile Hammers

Deepest Building Foundation in the World

SPENCER, WHITE & PRENTIS

FOUNDATIONS

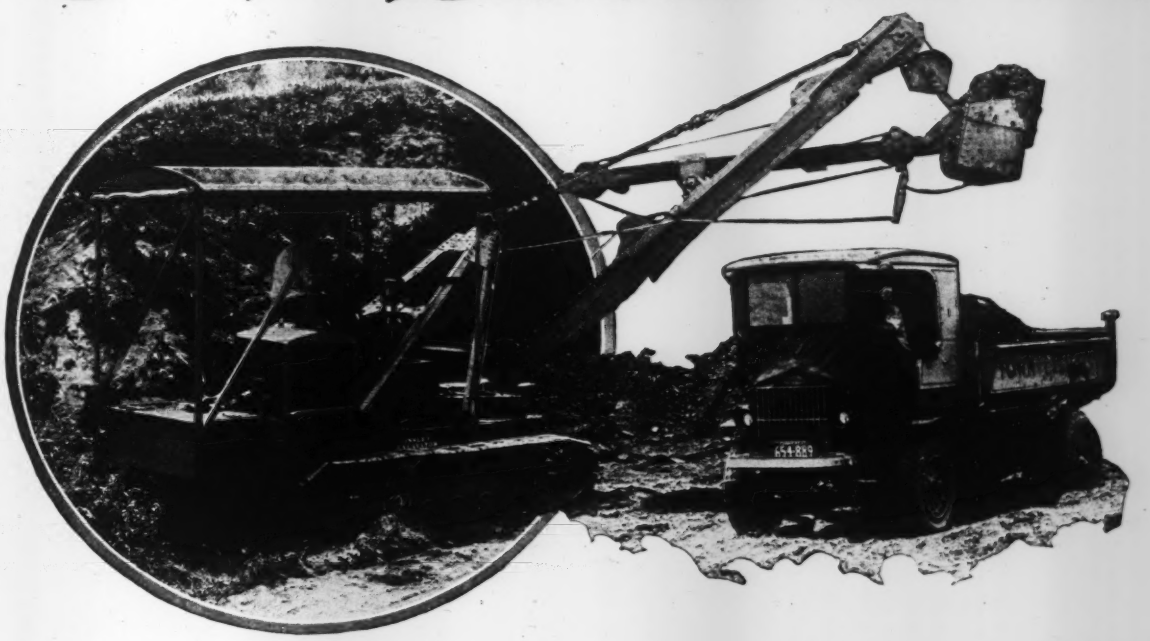


CLEVELAND UNION STATION
CAISSONS TO 250 FEET BELOW CURB

NEW YORK DETROIT CLEVELAND

THE INSLEY EXCAVATOR

for SHOVEL · DITCHER · CRANE
SKIMMER AND DRAGLINE WORK

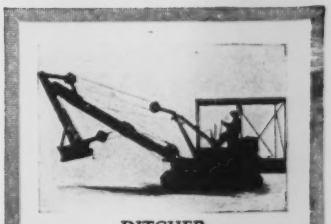


With Shovel Attachments

WORKING in a sand or gravel bank handling material from stock pile to truck, working in a borrow pit, or grading a street or road is ideal work for an Insley Shovel. It will handle from 200 to 450 cubic yards a day with great efficiency and at a low cost by virtue of its speed of operation, and will dig any kind of material satisfactorily. Its first cost is low, and it is strictly a one-man machine.

Ease of operation must accompany speed of operation if the best results are to be obtained. The Insley Shovel is easy to handle, so that the operator can get full hourly capacity without undue fatigue. This is worth money to the owner.

Write for Catalogue No. 49 and arrange to inspect one of these machines.



DITCHER

SKIMMER

DRAGLINE

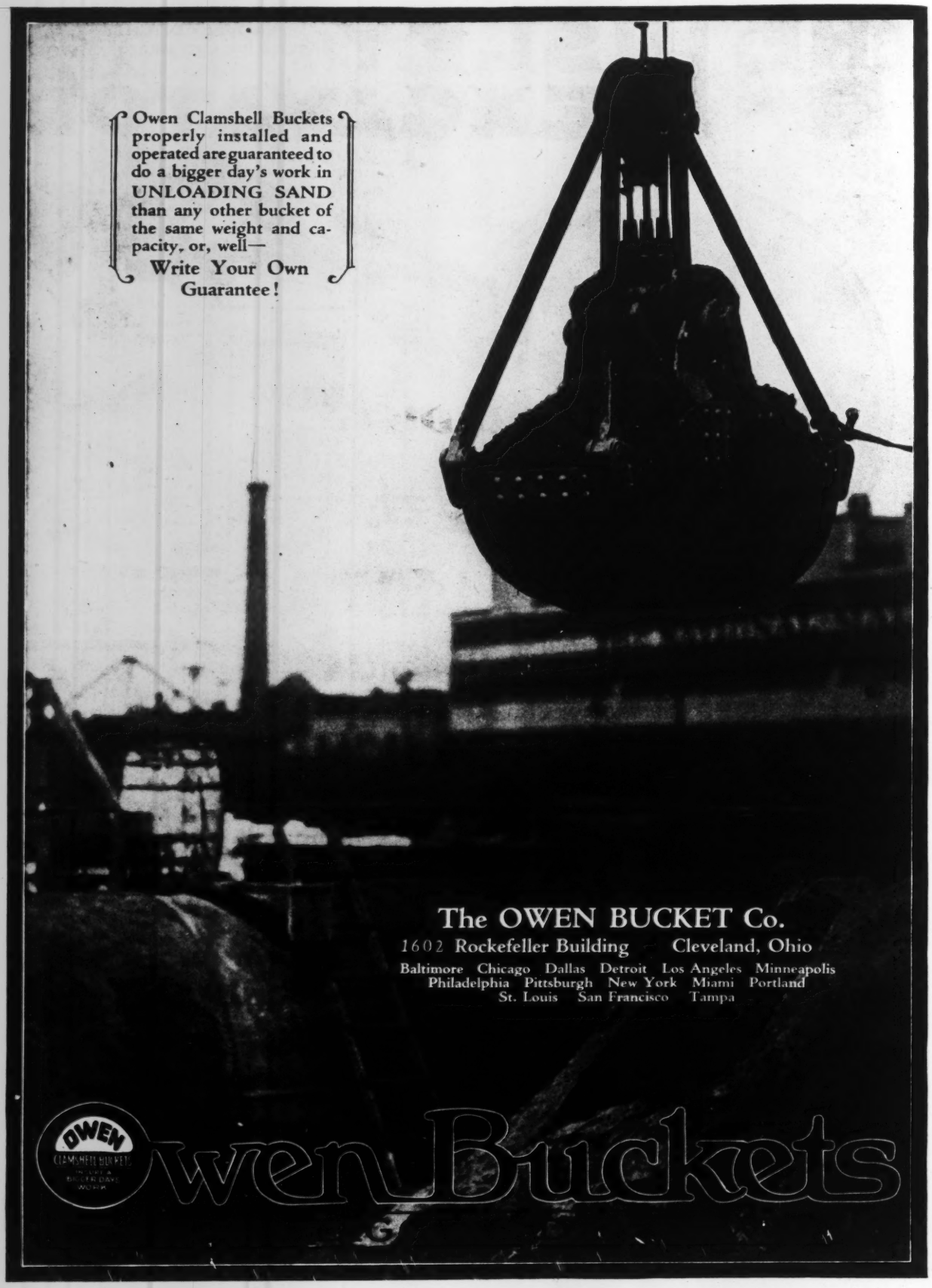
CRANE

INSLEY MANUFACTURING CO.

Engineers and Manufacturers
INDIANAPOLIS

INSLEY Concrete Placing Equipment : Steel Derricks
Buckets and Cars : Excavating Equipment

No. 487


Owen Clamshell Buckets properly installed and operated are guaranteed to do a bigger day's work in UNLOADING SAND than any other bucket of the same weight and capacity, or, well—
Write Your Own Guarantee!
The OWEN BUCKET Co.
1602 Rockefeller Building Cleveland, Ohio
Baltimore Chicago Dallas Detroit Los Angeles Minneapolis
Philadelphia Pittsburgh New York Miami Portland
St. Louis San Francisco Tampa
OWEN
Owen Buckets

Which?

—just a metal pipe

—or a metal pipe

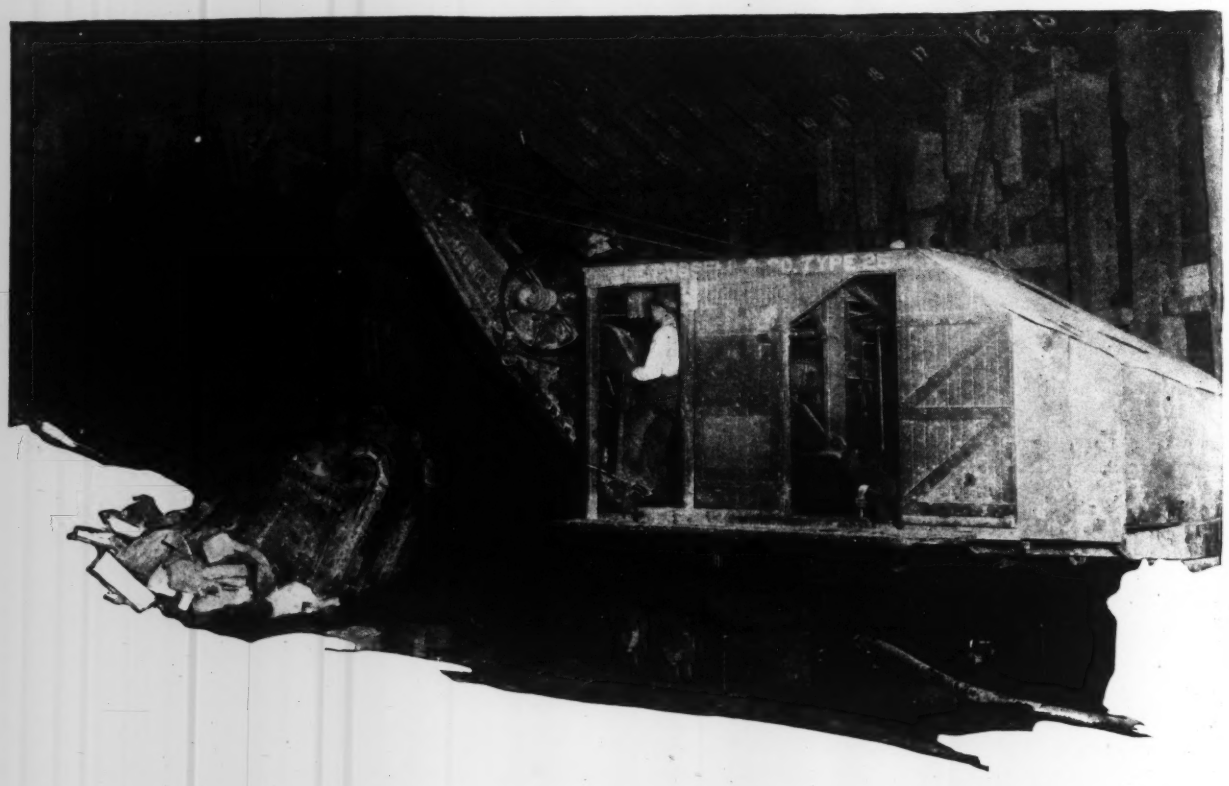
(1) lined & (2) ENCASED in

(3) REINFORCED CONCRETE?

LOCK JOINT
Steel Cylinder
Reinforced
Concrete Pipe
for Higher Heads

Sewer
Culvert
Pressure
Sub-Aqueous

LOCK JOINT PIPE CO.
Established 1905
9 Rutledge Ave., AMPERE, N. J.
CHICAGO
DENVER
KANSAS CITY



Hand in hand with progress—

The experienced digger understands value

In the busiest construction areas you'll find many a Massillon at work digging a new foundation. Where progress is greatest and construction must be carried on rapidly with modern equipment, the Massillon proves its value as it has in all its fields.

MASSILLON
STEAM SHOVELS

Built by
Steam Shovel Division

The Russell & Company **Massillon, Ohio, U.S.A.**

Deep Stuff!

THIS Marion Type 32 steamer is digging trench 18 feet deep. It has a 30 foot dipper stick. No, they didn't put a couple extra tons of coal in the cab for ballast. It's just a good example of the inherent stability of all Marions; the result of being built compact and low, of a large-diameter roller path, of crawlers long enough to prevent rocking without being long enough to bang, of plus dimensions everywhere strength and weight are needed, of a safety factor that fortifies against the unusual. This job is deep stuff for any shovel, but it is not too deep for a Marion.

Write for bulletins describing Marion Small Revolving Shovels, of which there are three sizes: 1 yd., 1½ yd., and 1¾ yd., all convertible to crane or dragline

THE MARION STEAM SHOVEL CO., MARION, OHIO
Established 1884

Marion *Power Shovels*

Come to Shovel Headquarters

G.L.1

Let Your Business Grow

Have you been letting good profitable jobs slide by because you didn't know about the New Bucyrus 100-B?

IT'S A DIGGER — LOTS OF POWER WITH A LOW OPERATING COST PER YARD

The New Bucyrus 100-B is just as mobile and as easy to handle as a small revolving shovel. But, it is bigger, more powerful and has a 3 cubic yard dipper.

This New Shovel revolves in a 16 foot radius. It works in close quarters and dumps high on the bank—23 feet. It's mounted on single truck caterpillars.

It digs with the punch and speed of the railroad type shovel, but it has a wider digging range and a wider dumping radius, than one of same length boom and dipper sticks.

Like the 120-B (Mine and Quarry Shovel), the ruggedness and power of the 100-B is greater than even the railroad type shovel.

The 100-B is a general utility shovel for contracting—for general excavating—for slag pits—for cement mill quarries—for all types of tough digging jobs where big yardage is essential.

For more information about new and bigger yardages and the new and bigger shovel that digs them, ask for Bulletin D-1005N

Bucyrus Company, South Milwaukee, Wisconsin

BUCYRUS

NEW YORK CHICAGO BIRMINGHAM SAN FRANCISCO PITTSBURGH TOKYO LONDON

745

Great Power but Light Weight

LORAIN 75

Reason No.

2

WEIGHT doesn't mean power, in man or machine.

It's the way power is applied that gives the little athlete the advantage over the big undeveloped bruiser.

Light weight is essential in a shovel or crane for easy handling, for quick movement and economy of effort. Great power is also essential to lick the tough jobs that are so frequently met in excavating. Neither end should be gained at the expense of the other.

Here then was another two way problem—to achieve greater power with no addition of weight. It required new methods to do it—Lorain 75 methods. A new drive principle secured more power through a more direct drive. It cut down weight by reduction of parts. It cut out lost motion. It reduced friction. The Lorain 75 bulletin explains this new drive principle and other reasons why this machine can lick your big enemy —Overhead.

The Lorain 75 is the champion athlete of excavating machines. It is capable of feats of power all out of proportion to its size.

Two Lorain 75s digging coral rock for the Highway Construction Co., at Miami, Fla.

Results—that's it

"SHOVEL functioning beyond expectations," says Charles F. Puff, Philadelphia, in a telegram.

"The State Department gave us 43,000 yards in June and July - - - - - at least 75% rock", writes Boso and Ritchie, Ravenswood, W. Va.

Every day brings enthusiastic telegrams and letters from Lorain 75 owners. Satisfaction everywhere—and why?

Because the Lorain 75 has the stuff in it. It does all that was promised and heaps besides. No necessity for claims as to what it will do —the Lorain 75 performs.

We will show you what it has done and what it is doing—at surprisingly low cost and without breakdowns.

After the job is finished and your ledger shows your profit—that's when you'll be glad you bought a Lorain 75.

THE THEW SHOVEL COMPANY

LORAIN, OHIO

Shovels-Clamshells-Draglines

Steam, Gasoline or Electric-Mounted On

The Center Drive Truck

Building Profits as Well as Bridges

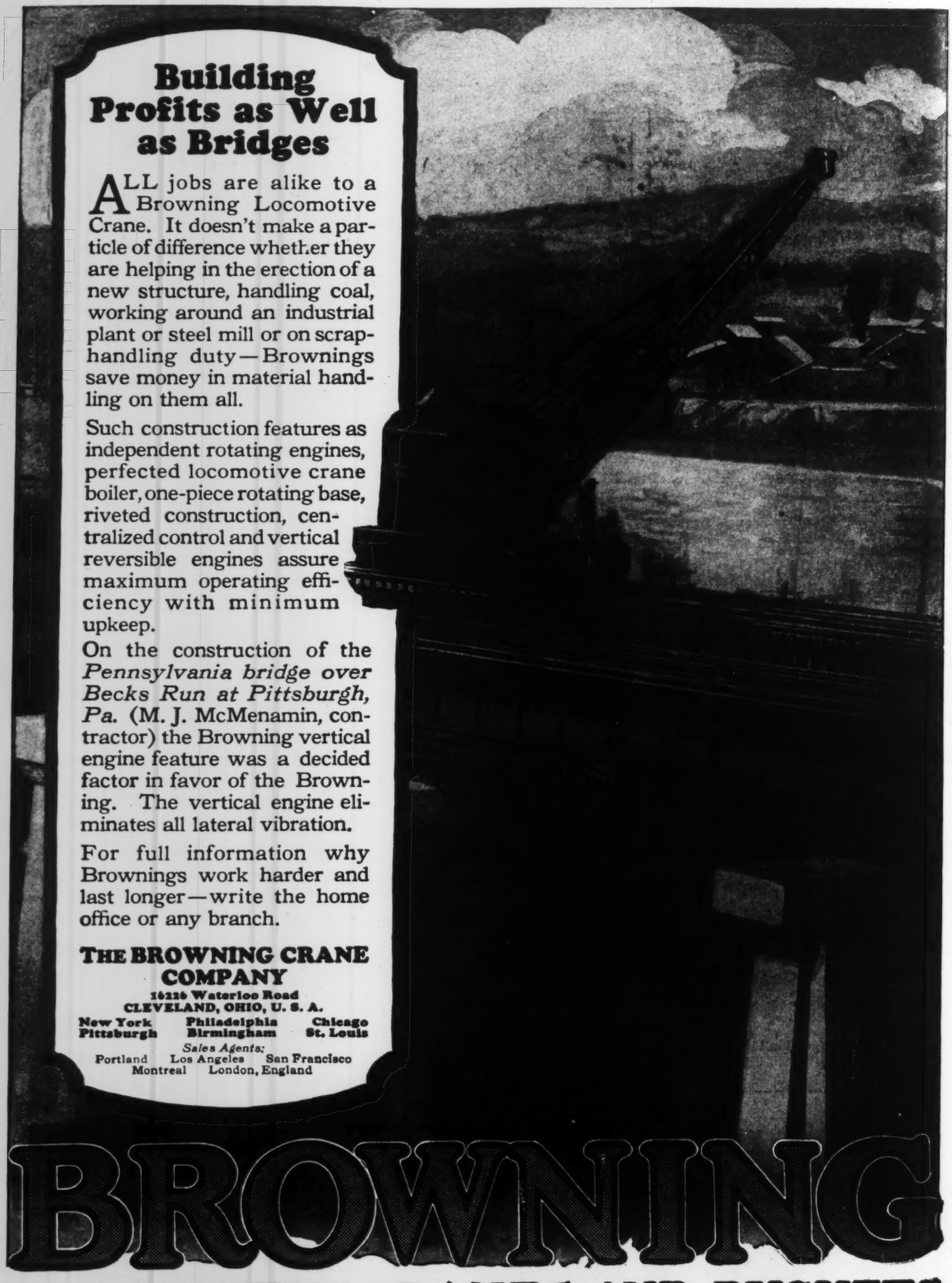
ALL jobs are alike to a Browning Locomotive Crane. It doesn't make a particle of difference whether they are helping in the erection of a new structure, handling coal, working around an industrial plant or steel mill or on scrap-handling duty—Brownings save money in material handling on them all.

Such construction features as independent rotating engines, perfected locomotive crane boiler, one-piece rotating base, riveted construction, centralized control and vertical reversible engines assure maximum operating efficiency with minimum upkeep.

On the construction of the *Pennsylvania bridge over Becks Run at Pittsburgh, Pa.* (M. J. McMenamin, contractor) the Browning vertical engine feature was a decided factor in favor of the Browning. The vertical engine eliminates all lateral vibration.

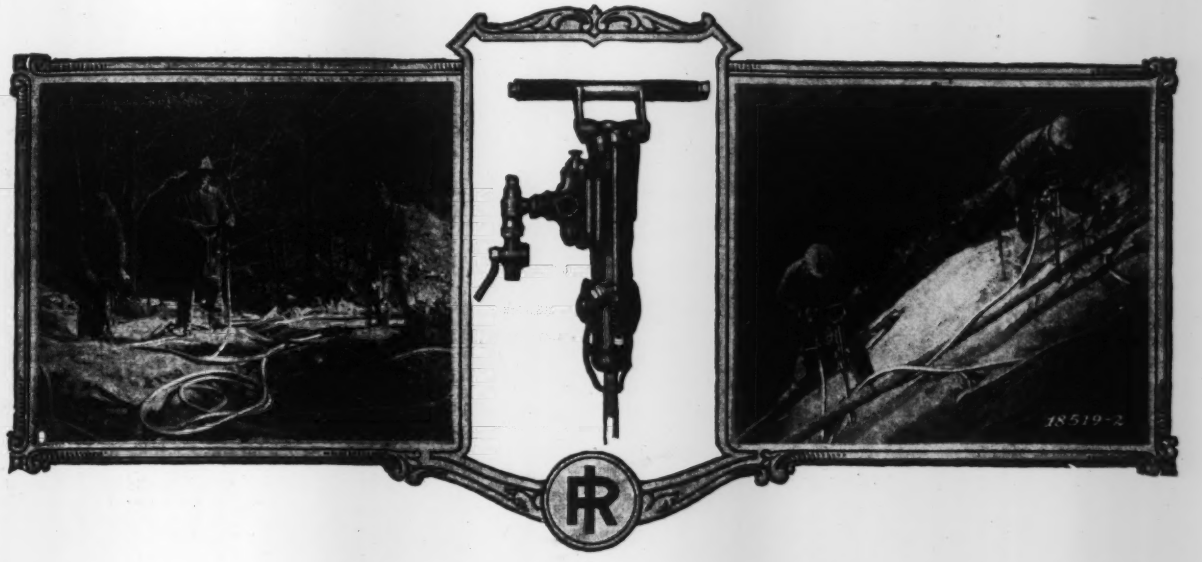
For full information why Brownings work harder and last longer—write the home office or any branch.

THE BROWNING CRANE COMPANY
16226 Waterloo Road
CLEVELAND, OHIO, U. S. A.
New York Philadelphia Chicago
Pittsburgh Birmingham St. Louis
Sales Agents:
Portland Los Angeles San Francisco
Montreal London, England



BROWNING
LOCOMOTIVE CRANES AND BUCKETS

The Universal One-Man Hand Hammer Drill



"Jackhamer"

The "Jackhamer" Drill is the answer to practically all surface rock drilling problems. One of these lightweight, self-rotating, hand hammer drills will put down holes as deep as 25 feet, averaging from 100 to 150 feet per day in hard rock.

A one-man drill. It can be used wherever the operator can get a foothold—on ledges, in trenches, in building excavations, in quarries — anywhere. The "Jackhamer" takes no time for set-up, and holes can be drilled easily at any angle.

The "Jackhamer" is a forged steel machine—one made to withstand the most severe duty. It is economical in the use of air. Rubber grips on the handle, an easily operated and reliable steel holder, and an effective hole-blowing device all add to the ease of operation.

There are six sizes of "Jackhamer" Drills, so that it is always posible to select a suitable machine for the work at hand.

BAR-33, 21½ lbs.; BBR-13, 37 lbs.; R-12, 40 lbs.; BCR-430, 45 lbs.; DCR-23, 55 lbs.; DDR-13, 73 lbs.

INGERSOLL-RAND COMPANY, 11 BROADWAY, NEW YORK

Offices in principal cities the world over

Atlanta	Cleveland	Houghton	New Orleans	Salt Lake City
Birmingham	Dallas	Joplin	Philadelphia	Scranton
Boston	Denver	Knoxville	Pittsburgh	Seattle
Buffalo	Detroit	Los Angeles	Pottsville	St. Louis
Butte	Duluth	New York	San Francisco	St. Paul
Chicago	El Paso			Washington

For Canada, refer Canadian Ingersoll-Rand Co., Limited, 260 St. James St., Montreal

296-JD

Ingersoll-Rand

Municipal Engineers—

86% endorse one method of protecting metal

—and their practice coincides with that of five other engineering groups

MUNICIPAL engineers strongly favor red-lead for protecting metal against corrosion. This fact was brought out by replies to a questionnaire recently sent out by a prominent engineering organization. Thirty-six of the 42 who replied, or 86 per cent, said they use, specify or recommend pure red-lead.

This only confirms the already convincing evidence of the wide use of red-lead by the engineering profession. The same questionnaire sent to the municipal engineers was also sent to representative men in other groups.

Here is what the others said: Forty-one of the 46 railway engineers who replied to the questionnaire also said they use, specify or recommend pure red-lead. Twenty out of 26 structural engineers; 40 out of 43 federal, state and county engineers; 18 out of 20 consulting engineers; and 24 out of 28 industrial engineers said the same. In view of the many paints on the market the agreement of these men is remarkable. It is an unanswerable argument for the effectiveness of red-lead paint.

Oil and gas men, too

In addition to these engineers, men in the oil and gas industries, who are vitally concerned with construction and maintenance of millions of dollars' worth of iron and steel equipment, were questioned in the same way. The replies showed that the same practice of using red-lead was as generally adhered to by these industries. And so it seems to be a proved fact that wherever men are faced with the question of metal surface protection, red-lead is the accepted material.

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The highest grade red-lead is Dutch Boy red-lead. It is used and recommended by the country's leading engineers. You can get it in either the paste or liquid form. The liquid comes in the natural orange-red for next-to-metal coats, and also in browns, greens and black for finishing coats. The paste is obtainable in the natural orange-red and may be shaded to any desired dark color.

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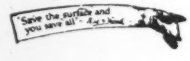

Dutch Boy Red-Lead

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"Contraction cracks can easily be avoided"

says CLIFFORD OLDER

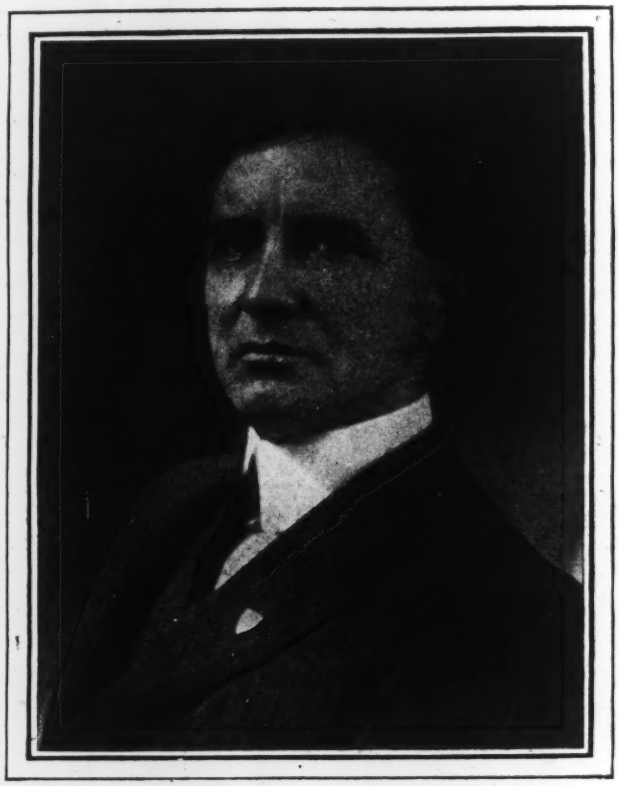
IT is well known that concrete pavements expand and contract due to changes of temperature and changes in the moisture content of the concrete," said Clifford Older, nationally known authority on concrete highway construction and a former Chief State Highway Engineer of the State of Illinois, before a recent meeting of the South Side Improvement Association of Park Ridge—one of Chicago's leading suburbs.

"But contraction cracks can easily be avoided by dividing the pavement into slabs sufficiently small so that the frictional resistance does not develop excessive tensile stresses in the concrete or the steel reinforcement used. Trouble due to the compressive stresses set up by expansion may be minimized by using concrete of uniformly high resistance to compressive stresses—but even then it can more certainly be avoided by the introduction of a proper yielding material between sections.

"Experience indicates that the aggregate thickness of expansion joint material per 100 feet of road should be about double the free expansion to be provided for, or about one and one-half inches per 100 feet of pavement. Good expansion joint material, one-half inch thick, properly placed at about 30-foot intervals, gives excellent results.

* * * * * *

For many years Carey Elastite Expansion Joint has been the choice of successful engineers and builders, everywhere. Today, enough Carey Elastite Expansion Joint is in use to carry out Mr. Older's recommendation on a concrete road 37,000 miles long, 7 inches thick and 18 feet wide.



Clifford Older, of the firm of Consoer, Older and Quinlan, Consulting Engineers, 140 South Dearborn Street, Chicago. Mr. Older is a noted authority on concrete highway construction. He was formerly Chief State Highway Engineer of the State of Illinois, and is largely responsible for the magnificent concrete highway system of that state.

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How Carey Elastite Expansion Joint is used around grating and in curb and pavement construction in Park Ridge — a progressive Chicago suburb.

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FRANK C. WIGHT
Editor

Volume 97 — NEW YORK, SEPTEMBER 30, 1926 — Number 14

For All Engineers

FEW engineers will ever be called upon to design or to build a 1,700-ft. suspension bridge, but every engineer worthy of the name is interested in the details of such design and construction. For a great bridge comes near being the crowning effort of the engineer's art and to know something of how such monuments are built is a necessary part of every engineer's education. To supply the needs, then, of the general engineer and not necessarily to inform the comparatively small circle of bridge experts the article which starts in this issue has been prepared. No bridge ever had a more thorough preliminary study or a more careful application of both precedent and research. For that reason fully as much as for the specific details which are explained the article should interest every engineer, whatever his specialty.

October Warning

REPORTS of near zero weather from the Northwest remind us to look at the calendar and looking we see that October is hard upon us. October means frost at night, cool mornings and slowly rising mercury to a midday genial warmth which deceives. Concrete builders take warning. Every one of you knows that concrete does not set up in freezing weather; nearly every one knows that in that chilly range between 32 and 50 degrees concrete sets up but slowly. But failures every autumn show clearly enough that mere knowledge is a slender reed where practice does not follow. It is a trite warning we give, but a serious one. Watch your concrete and your thermometer these fall days. Frozen concrete means early collapse at the worst, and early disintegration at the best. Concrete placed in the dangerous forties without the simple precautions too well known to repeat means delayed setting, with probable collapse from too early form removal.

Mostly a Gesture

NEW YORK State's water power commission is going ahead with its plans for the licensing of a private corporation to develop water power on the St. Lawrence River. Some months ago, the state engineer, a member of the commission, outlined terms on which a license would be issued. Now these terms have been formally adopted by the commission and it will, on Oct. 15, hold a final public hearing on the two applications for preliminary permits which are before it. Both applicant companies have strong financial backing and the indications are that both will accept the conditions enumerated by the commission, thus putting the commission in a position to issue a preliminary permit to whichever one seems to offer the state the most advantageous proposition. These developments are interesting, but largely from an academic point of view because any permit which the State of New York may issue at this time only gives to the applicant a prior lien on such indefinite rights to develop power in the St. Lawrence as the State of New York may possess in the southern half of the river. Similar rights in the northern half vest with the Province of Ontario and the rights of both are subject to the indisputable rights of the Government of the United States on the one hand and of the Dominion of Canada on the other over navigable waters. Before any dam can be built across the international section of the St. Lawrence River, four sovereign powers must come to an agreement as to the type of structure and the conditions under which it is to be built, and no one of the powers can bring pressure upon all of the others in order to force an agreement. The New York action significantly coming a month before election looks like little more than a gesture.

Mosquito Triumphans

FROM all over the rain soaked East come reports of a mosquito plague. The victims, slapping and scratching, take it with Job-like patience or irate resentment, as their temperaments react, but they all accept with unquestioning confidence the theories of the experts as to the cause of this most pestiferous of the minor annoyances that man is heir to. How much longer are the entomologists to be allowed to point out this cause without offering pragmatic proof? They cleaned the mosquitoes out of Panama, but they cannot clean up Cape Cod or New Jersey. Is it possible that the gentlemen who pursue so inquisitive a nose into the life habits of the winged pests have missed something? Is it not time that some proof were advanced that the money expended in mosquito prevention in the temperate North has really had any result? The mosquito continues to come and go at his own sweet will, and swamp drainage and gutter inspection availeth little. The pure science which theorizes on the mosquito may be basically correct; the practical results of that theorizing are a lamentable failure.

Where It Listeth

THE vagaries of rainfall are unexplainable. The past week exemplifies once more this oft-made observation. In the Middle West large areas of harvest high fields are flooded out with high water which might be expected in the spring when melting snow adds its volume to the falling rain, but which is rare, and some cases unique, in this particular territory in the autumn. And in New York City, which has been to its residents a succession of rainstorms for a month, the city authorities are issuing warnings against water waste because the Catskill area, a hundred odd miles away, has been experiencing so great a drought as to leave the city's reservoirs there in a dangerous state of depletion. When it comes to rain anything can happen.

Capacity to Pay

LAST week at a meeting in Philadelphia, Charles Piez, of the Link-Belt Company, reminded his hearers of a fundamental of industrialism that is too often forgotten. "Though the employer owns the shop and equipment" he said, "though he controls the management and the policy, though he exercises the right of hiring and firing, in the final analysis, his responsibility consists of finding a market in which he can dispose of the labor of his workers. That being the case the price he fixes for a unit of labor cannot be satisfactory to the worker alone; it must be satisfactory to the purchaser as well. . . . The employer in a free and competitive market neither fixes the rates of wages, nor does he, except in an intermediate capacity, actually pay them. They are fixed and paid for by the purchasers of the commodities of which the worker's labor is a component part. . . . The employer's attitude toward wages, therefore, is a compromise between the expectations of the workers and the willingness of the purchaser to pay." This is a lesson the building trades may take to heart. In an expanding market, the contracting builders can continue to meet the demands for more and more money for labor. Saturation is bound sooner or later to occur in construction; the marginal structure will increase, that is the one which will be built if it is to cost so much, but which can be done without if the price goes higher. There are signs that such a point is near. If building labor is wise it will take heed of its prospective effect first on demands for higher pay and then upon the existence of enough work to go around.

Desmond FitzGerald

IT FALLS to the lot of but few engineers to live as long, as fully and usefully as did Desmond FitzGerald. His motto as a beginner was to do everything he undertook as well as it could possibly be done, even though it were the sharpening and marking of stakes which attracted the attention of the engineer above him at the very outset of his career. But he went far beyond that. He pioneered and, still living up to his motto, contributed materially to the advancement of his profession, of science, and of mankind. This is enough to make a marked man but it was only part of the life of Desmond FitzGerald. He joined culture with utility. Witness his tree and shrub planting around Chestnut Hill reservoir before such ornamentation was as common as now, his highly artistic work as a photographer of natural scenery at home and abroad, and the art treasures with which he filled his home until it overflowed and they filled a large gallery, which for many years was thrown open to the public. Although retiring from engineering work a number of years ago, as well he might at his age and with his achievements, Mr. FitzGerald set an admirable example by continuing his broader activities to the end of his fourscore years. This he could not have done so fully and effectively if he had not gone beyond the common lines of professional work early in life.

How long this dean of the profession outlived those who were actively engaged in engineering a half century ago is shown by the list of members of the American Society of Civil Engineers who attended the Boston convention of 1878, as reported in *Engineering News* of June 27, 1878, in which he took a leading part as chairman of the excursion committee. Long gone are most of those on the list, even though a goodly number of them must have been younger than Mr. FitzGerald.

That a broader outlook on the busy world and continued activity and interest in many of the higher things of life had so much to do with attaining so ripe an age there can be no doubt. The lesson to younger engineers is obvious. In fact few are too old to profit by it to some extent.

Compulsory Railway Electrification

NEW YORK'S railway electrification law has been declared unconstitutional. This law, known as the Kaufman act, passed by the State Legislature in 1923, required that all railways within the limits of cities of a population of 1,000,000 or more, or within the limits of a city adjoining such city, must be operated by electricity after Jan. 1, 1926. Subsequently the State Public Service Commission was authorized to extend the limiting date for not more than five years. Curiously, the court which found the law unconstitutional did not base its findings upon the principal grounds upon which the law had been attacked, that of violating the fourteenth amendment of the Constitution in depriving the railways of their property without due process of law, but on the grounds that the state law conflicts with the powers of the federal government over interstate commerce, Congress having vested the Interstate Commerce Commission with authority to dictate what type of locomotive shall be used by the railways. This seems like a far-fetched interpretation of the law, but it may be that the judges of the court, believing the law to be unjust, have decided that this interpretation is more likely to be sustained as a point of law in the higher courts than would a finding under the fourteenth amendment.

However, aside from the legal features or merits of this particular case, the finding of such a law unconstitutional is in the best interests of the country in general. If a state legislature can order railroads to make large expenditures without the responsibility of providing the same railroad with just compensation for the expenditures, there seems to be nothing to prevent such action being carried still further, as was done in Buffalo, N. Y., where the city fathers passed an ordinance requiring all railways to electrify their lines within the city limits. Most cities and states would prefer to see the railways within their limits electrified, but the expense of such work is great, and the local governing bodies can hardly be expected to consider the possible greater needs of parts beyond the limits of their control and direct interest. Some body with responsibilities to stockholders and users alike must be empowered with decision in such matters.

Orders which require large expenditures by the railways, whether they be for railway electrification or for the elimination of grade crossings, where they cannot be arranged for by mutual agreement between the railway companies and the cities or states concerned, should not come from the local government, but should come from the agency of the federal government which controls the finances of the railroad company, the Interstate Commerce Commission.

Misunderstood Engineering

IT HAS become more or less popular to marvel at what the engineer does, to rhapsodize over his high buildings and his mighty dams, to canonize him as the prophet of the future. Unfortunately for the engineer this enthusiasm stops there and rarely goes so far as to be reflected in the income tax that the engineer pays. It is as though the public felt that to be able to bend the will of nature to serve man was in itself sufficient reward. However that may be, it takes a major catastrophe like the San Francisco earthquake or the Florida hurricane to show the engineer that this worship of what he does is the worship of the mysterious, a manifestation of man's hereditary propensity to admire what he does not understand.

The press reports from Florida make this very clear. These reports are written by trained observers, men whose duty it is to interpret the common view, to see things that the man on the street wants seen, and to satisfy the common desire. And yet in the deluge of words that has come out of Florida since September 18 there has been practically nothing that would indicate that those whose duty it is to tell what happened there have any notion of the service that engineers render or the significance of that service in providing the habitations and the structures and the machinery that make a modern city livable.

The newspaper man, to be sure, has a self-manufactured notion of what he considers "human interest." It is a little hard to define but it may be illustrated by saying that a reporter in Miami on that awful Saturday would have considered his fortune made if he had found a mother cat caring for a brace of puppies under one of the overturned boats in Royal Palm Park. It may be more specifically illustrated by the fact that of the hundreds of photographs submitted to this office by the press associations, fifty per cent are of small boats washed up on a beach, which happens every time the wind blows very hard on Lake Erie, thirty per cent the destruction of small bungalows that probably would have gone down in a fifty-mile gale and the rest pictures of bent and broken palm trees. It was apparently far beyond the ken of the usual newspaper man—and he knows what his readers want, make no mistake—that the stability or lack of stability of a modern office building or hotel or the behavior of a modern bridge, or the reliability of a water supply, were of any consequence to anyone. Further than that, they have not so far reported just how so many people came to be killed. All the reporters were overwhelmed with the force of the natural elements; how that force affected the man-made aids to living does not concern them.

Take another instance. Almost the first report out of Florida was that a "typhoid epidemic was imminent." This has a familiar ring. It follows every great flood, or fire, or earthquake. It is one of the fetiches of the newspaper office, but no one has ever taken the trouble to check up on the past and find out just how many such epidemics have ever occurred. We know of none. Just the same, next February when New York's east side streets will have their usual accumulation of garbage dumps on every snow pile the New York papers will carry their usual demands that this "disease-breeding filth" be removed. It is a testimonial to the half knowledge that is prevalent, this belief that dirt and disorder necessarily mean disease.

It is not to be expected that the ordinary man would be interested in all the technical detail of the behavior of structures under untoward conditions. That is obviously for the engineer alone. It is only in the great tests to destruction that the engineer really knows how close to failure his design is. But until the layman has more appreciation of what design means, of the difference in performance, say, between the well-built steel frame building subjected to a 130-mile gale and the flimsy bungalow in the same wind, the engineer cannot feel that his contribution to the world is properly appraised. Reward for services implies some understanding of the effort behind those services and if the great American press properly interprets the American people in the reports on the Florida hurricane the understanding of what engineering is and does is practically nil.

British Refuse Disposal

THE half century of municipal refuse disposal in Great Britain following 1875 saw little change in fundamentals. The ideal worked toward but fully attained only as regards a small percentage of all the town refuse produced was high temperature incineration of the entire volume of mixed refuse which the householders consign daily to the historic dustbin, with utilization of the otherwise waste heat of combustion for the production of electric light and power or for pumping either water or sewage. Notwithstanding the many refuse destructors built, vast quantities of municipal refuse were still being sent to the "tips" or dumps when the Great War paralyzed all municipal and other activities which its searching tests held to be non-essential. Refuse disposal suffered with other activities—at least to the extent of curtailing some operations. Labor scarcity and costs set wits to work to reduce the volume of material put through the destructors and at the same time demands to conserve and use everything utilizable stimulated the salvaging of paper and other recoverable wastes. These factors have wrought notable changes in municipal refuse disposal wherever other than "tipping" or dumping were in use a dozen years ago or have since been introduced.

Current practice in five cities having destructors is reviewed elsewhere in this issue. It discloses a variety of screening and other salvage methods, the latter extending to ashes and other fine dirt and the clinker removed from these. In the old days, it was common but not universal to put everything through the destructor, thus producing a residue reaching to 25 to 40 per cent of what was fed into the furnaces. At many works this residue was screened, the clinker crushed and again screened, with utilization of the clinker, at least, for various purposes. Under the present plan, the separation and other recovery work precedes the destructor, leaving the latter much less to do than formerly, and that chiefly with combustible matter useless for anything else. In so far as American refuse disposal practice deals with mixed refuse there should be some lessons to be learned from these changes in Great Britain. American engineers and city officials will do well to note, for whatever it may teach them, that large volumes of British refuse still go to the dumps and that the article already mentioned tells how one British municipality is using the refuse for land reclamation instead of attempting to reclaim some of it and burn the remainder.

Bridging the Delaware River at Philadelphia—Part I

Project a Century Old Realized at Last by Public Enterprise on a Basis of Amortization of Cost by Tolls —Many New Problems—Rapid Construction Results in Opening Bridge Before Predicted Day

A two-page insert plate, facing p. 534, accompanies this article.

WITH the opening of the Delaware River bridge between Philadelphia and Camden on July 4, the world's largest suspension bridge went into service. The structure is the tardy realization of a project dating back fully a hundred years but not carried out until the states concerned, New Jersey and Pennsylvania, undertook the work jointly. As they are now operating it as a toll bridge to refund the cost, it probably ranks as the largest public toll enterprise ever carried out.

FIG. 1—DELAWARE RIVER SUSPENSION BRIDGE, VIEW FROM CAMDEN TOWARD PHILADELPHIA
As seen after completion of main structure, with only finishing and approach work to be done before admitting traffic.

Both in technical and in esthetic respects the bridge is a distinguished achievement. Its unusual size and the prospective traffic demands called for the highest order of engineering skill and created many serious special problems, some of which led to experiments resulting in fundamental contributions to future suspension bridge engineering. The undertaking also presented an outstanding architectural opportunity. This received careful attention from the beginning and the joint effort of engineer and architect was directed toward attaining idealized line and balanced proportion for most pleasing effect.

One of the noteworthy technical achievements in the work was the completion of the bridge, ready for regular traffic, three days earlier than the day promised in the engineer's preliminary report, written a year before construction began. At that time, early in 1921, they stated that the recommended type of bridge at the selected location could be completed ready for traffic by July 4, 1926, the date of Philadelphia's sesquicentennial celebration of the Declaration of Independence. The bridge was opened to regular traffic on July 1.

Origin of Project—Proposals for building bridges across the Delaware at Philadelphia date back at least to 1812, but cost and technical difficulty kept all of them from success. Instead there was an active development of ferry service, which until the current year has supplied the only highway crossing south of Trenton.

Within the last 15 years, however, demands for a bridge or tunnel crossing of the river became insistent. Reports were made by several special boards and commissions, establishing that a bridge was feasible and could be built at a cost that made the undertaking worth more detailed study. These preliminaries led to legislative action by the two states in 1919 providing for an interstate compact to join in the construction of a bridge, and such a compact was soon after formulated and approved. Under its terms the bridge has been built by the joint action of bridge commissions of the two states, with representation also of the city of Philadelphia, which undertook to meet half of Pennsylvania's cost.

Upon the organization of this joint body, it selected a board of three engineers to direct the design and construction: Ralph Modjeski, chairman and chief engineer; George S. Webster, and Laurence A. Ball.

Site and Type—The location of the bridge was selected from among a number of proposed sites, the five most prominent of which are indicated in Fig. 2. The choice was based on a desire to place the bridge near the east-west axis of Philadelphia, Market St., and toward

FIG. 2—LOCATION OF BRIDGE, AND, SHOWN DOTTED, SOME ALTERNATIVE ROUTES CONSIDERED

the side of the largest extent and growth of the city, that is, northward.

A clear span between pierhead lines, corresponding to a spacing of main piers of 1,750 ft., and a clearance height of 135 ft. were necessitated with regard to shipping. Property conditions, at least on the Philadelphia side, rather narrowly fixed the land-span length. The layout thus indicated was suited for either cantilever or suspension bridge construction. Subsoil conditions made either type of structure feasible, though they rather favored the cantilever span; bedrock formed a nearly flat floor 60 to 100 ft. below tidewater, the slope being downward toward Camden. However, comparative designs showed the suspension bridge to be 10 to 20 per cent cheaper, and as it permitted construction under a number of separate contracts, which was best suited to the plan of annual appropriation of funds, it was recommended by the engineers and adopted by the commission.

The cost was estimated at $28,900,000 (construction $20,800,000, land $6,800,000, contingencies and engineering $1,300,000). In the actual execution, however, these figures were overrun by 12 per cent in construction and 70 per cent in land. The actual cost was about $36,300,000.

Project Economically Justified—Traffic estimates based on ferry data (Fig. 3) showed a cross-river traffic of about 2,500,000 vehicles in 1921, and led to a conservative forecast of 6,000,000 in 1930, increasing to 15,000,000 to 20,000,000 vehicles per year 12 or 15 years later. These traffic volumes at any reasonable valuation of the crossing privilege—25 to 50c. per vehicle—assured an earning power ample not only to carry the annual charges but also to amortize the total cost within 20 years. Subsequent developments have even bettered these figures. The adopted toll rate of 25c. per vehicle

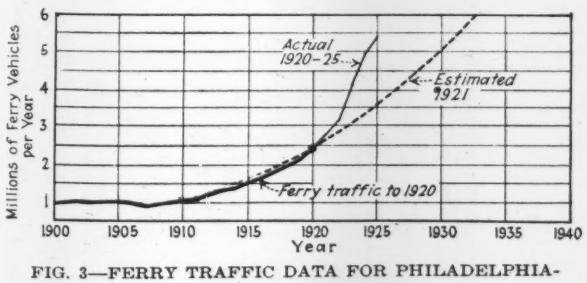


FIG. 3—FERRY TRAFFIC DATA FOR PHILADELPHIA-CAMDEN CROSSING

now promises to retire the whole cost of the bridge in less than 15 years.

General Design—A great main highway artery was to be created by the bridge, connecting the road systems

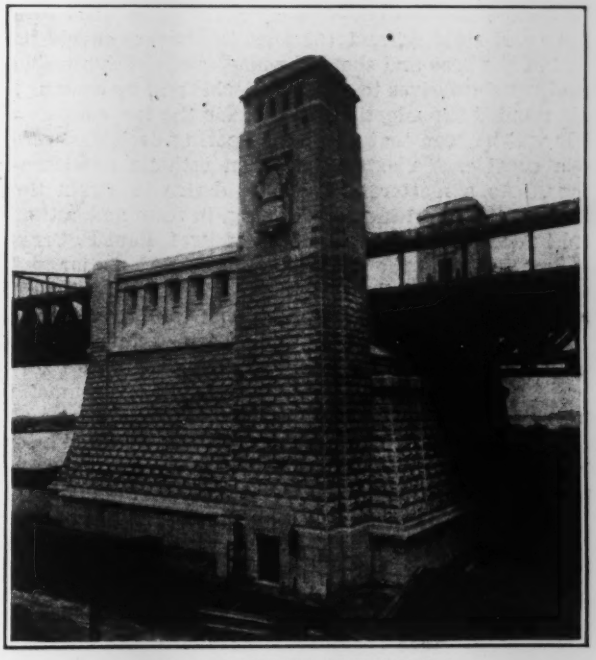


FIG. 4—CAMDEN ANCHORAGE
Illustrating the architectural development of the bridge.

of two populous states and also serving for intercommunication between Philadelphia's 2,000,000 and Camden's 150,000 of population. With this object in view, the engineers chose a six-lane roadway, 57 ft. wide, four tracks for street cars or rapid-transit tracks, and two 10-ft. footwalks, as representing adequate and practicable arterial capacity. Accordingly, the spacing between trusses or cables was set at 89 ft., which contemplated bracketing one track on either side outside the trusses. The footwalks were placed above roadway level. In the first design a plane of upper laterals was provided between the top chords of the trusses, and the footwalks were carried on these laterals. Later restudy of this design, mainly from the esthetic viewpoint, led to elimination of the overhead bracing. It was found

to be practicable to carry all lateral forces down to floor level by developing the bridge cross-section as a rigid frame, and the sidewalks could then be bracketed to the posts.

A bold decision was made by the engineers in adopting at the outset two-cable construction (though all recent large suspension bridges had been built with four cables) as giving greater structural simplicity and definiteness of stress distribution. The two cables (parallel-wire construction being presumed) would be 30 in. in diameter, half again as large as the largest ever built, those of the Manhattan Bridge. But the engineers felt certain that cables of this size could be built satisfactorily and would be as efficient as smaller cables. Both the construction experience and the results of special tests later confirmed their judgment most gratifyingly.

Other features of the suspension system early decided upon by the engineers were (1) that the land spans should be suspended from the cables rather than independently supported, (2) that the stiffening trusses should be kept wholly below the cables, (3) that the rather large sag of 200 ft. should be used, (4) that the stiffening-truss system should be limited to moderate depth and rigidity, and (5) that the towers should be fixed at the base and should be made sufficiently flexible to adjust themselves to change of cable pull by bending; this implied the adoption of steel for the towers.

It will be seen that these engineering decisions were to a considerable extent based on esthetic considerations. As a matter of fact, the desire to attain the best esthetic effect in proportioning, in form and outline and in detail led to the engaging of Prof. Paul P. Crret as architect, and the determination of both major and minor features of the structure was carried out with constant interchange between engineer and architect.

Foundations—Under the rather favorable rock and soil conditions at pier and anchorage sites, two different types of construction were adopted: pneumatic caissons for the main piers (in the river) and groups of open-dredged piers for the anchorage (on land). Fig. 4 shows the completed Camden anchorage and drawings in the second article will show details of foundations.

The pneumatic pier work was simple and not abnormal in size, but the caissons were distinguished by a steel working chamber with all-steel cutting-edge construction braced by brackets so as to leave the chamber free of bracing struts, as well as by a communication chamber or refuse chamber cored out in the concrete above the roof. The latter, provided as a safety measure and as a refuge during blasting, proved so convenient that with its exit air lock it was used to the exclusion of the regular man lock. The caissons, 68 ft. 8 in. by 143 ft., were built to full height in a shipyard and were launched complete, so that no subsequent cofferdam framing was required. They passed through mud and sand to a depth of 58 ft. below high water at the Philadelphia pier and 82 ft. at the Camden pier, with maximum air pressures of 28 and 34 lb. respectively. They and the granite-faced piers surmounting

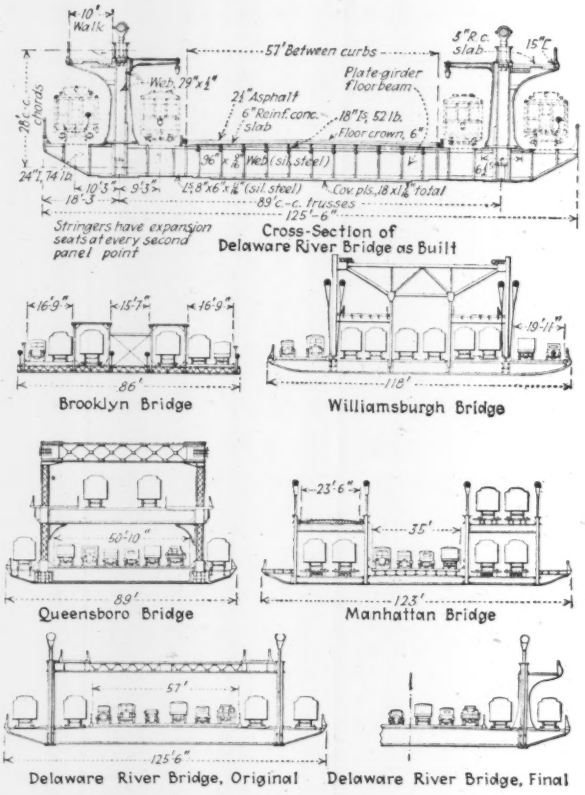


FIG. 5—MODERN TRAFFIC DEMANDS CALL FOR AMPLE DECK SPACE

Comparison of the several cross-sections of large bridges brings out not only the large roadway capacity of the Delaware River bridge, but also the open arrangement of the traffic space. Note that the first design showed an upper lateral system, later eliminated in order to make the roadway more nearly like an open highway.

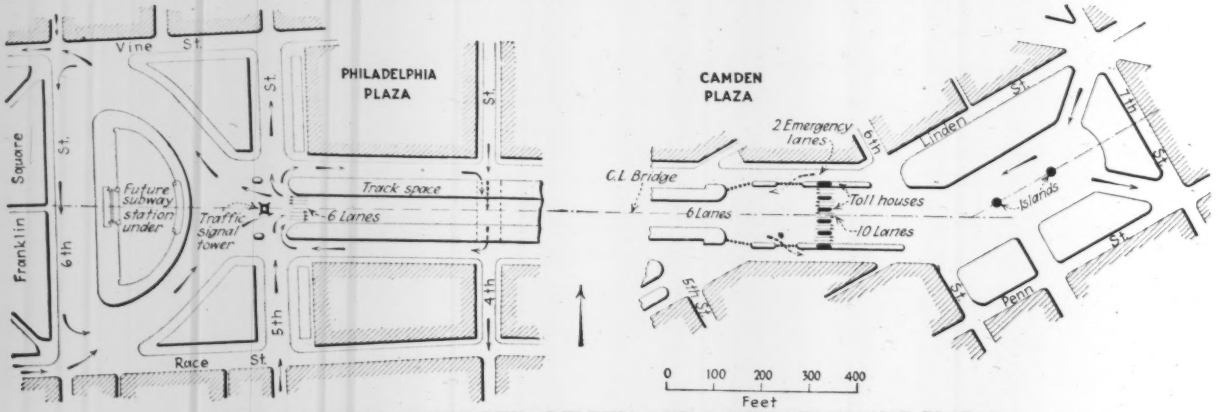


FIG. 6—LAYOUT OF THE PHILADELPHIA AND CAMDEN ENTRANCE PLAZAS

them were constructed during 1922 by the Keystone State Construction Co. in conjunction with Holbrook, Cabot & Rollins Corporation, at an average cost of

division to the method of functioning of the foundation, a long rectangular foundation pier was provided along either side of the anchorage, and a series of small cir-

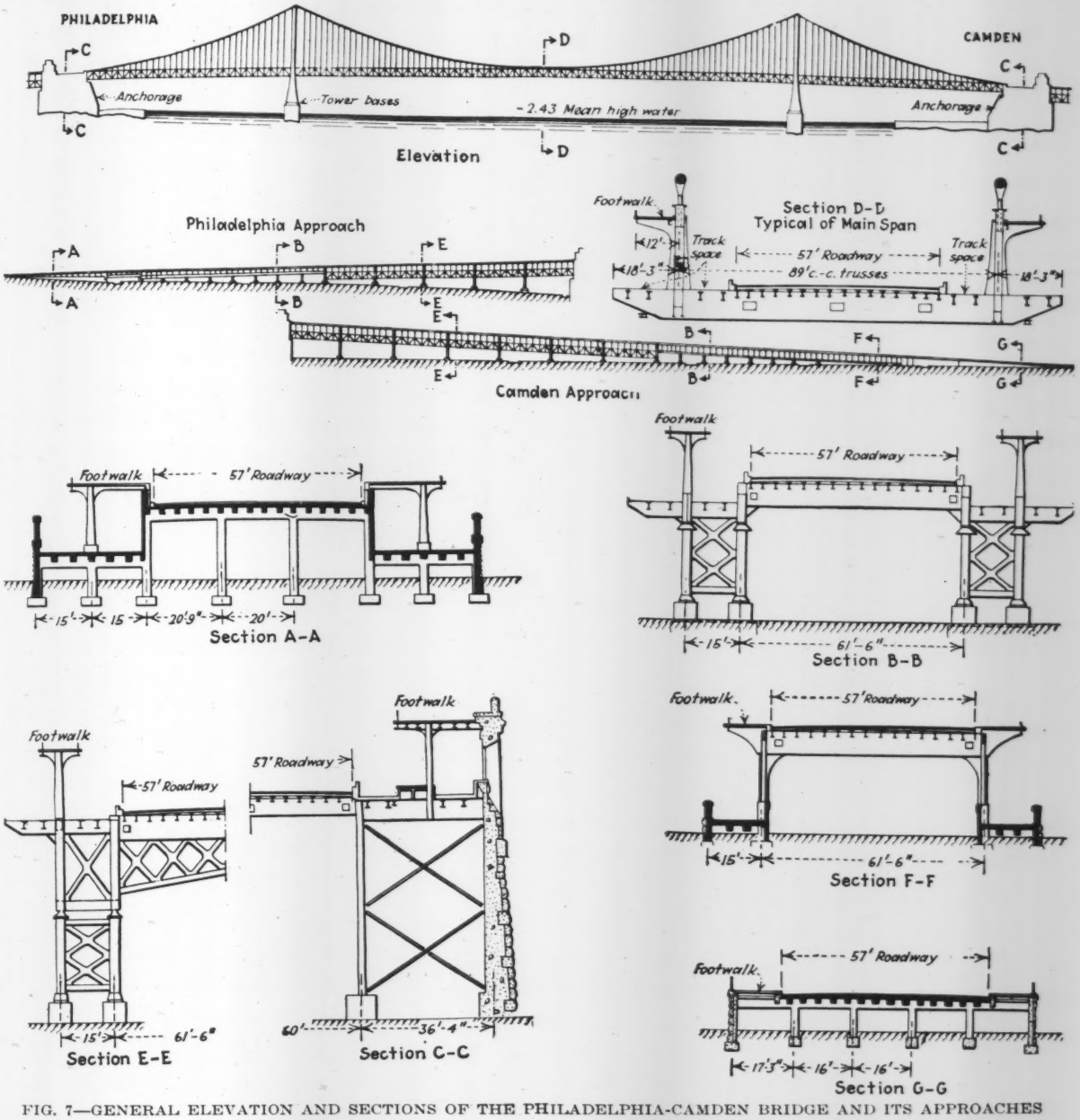


FIG. 7—GENERAL ELEVATION AND SECTIONS OF THE PHILADELPHIA-CAMDEN BRIDGE AND ITS APPROACHES

$28 per cubic yard of pier and foundation (total quantities 26,900 and 31,600 cu.yd., final contract cost $744,839.15 and $897,039.88 for Philadelphia and Camden piers respectively).

A much less simple problem was presented by the anchorage foundations. While some other large suspension bridges, where rock is not exposed or found at shallow depth, have anchorages supported on piles or wooden grillage, it was thought proper here to go to rock, the depth below ground being about 75 ft. at Philadelphia and about 110 ft. at Camden. An anchorage structure of the required length for due stability at this height was so large as to make it advisable to divide the foundation into several units. Adapting this

cular piers under the rear portion; the former to take all of the horizontal pull and carry the main part of the anchorage weight in the completed condition, while the smaller rear caisson had the important function of carrying the excess weight at the rear of the anchorage before the cable pull was brought to bear on the structure. The large caissons were 40x125 ft. at Philadelphia and went down 61 ft. below high water; those at Camden were 40x140 ft. and went down 102 ft.

Both large and small piers are reinforced-concrete caissons sunk by open excavation through dredging wells, as described more fully in *Engineering News-Record* of June 4, 1925, p. 920. Their sinking was greatly facilitated by the possibility of pumping them

out when the cutting edge approached rock so that the last part of the excavation could be done in the dry, which assured a satisfactory and even foundation bed. The rock, a schistose material, was disintegrated to some depth in its upper 5 ft. or more, and a foundation bed of the desired hardness and solidity was found only after excavating some distance through the decomposed part. This was also true at main pier foundations.

The anchorage body was built in two sections. The first section, built by the same contractor as the main piers, involved a total volume above the foundations of 33,300 cu.yd. for the Philadelphia and 33,900 cu.yd. for the Camden anchorage, furnished at an average cost of $7 per cu.yd. These figures include the concrete forming the seats for the anchorage bents and the incasement of the anchorage girder grillage. The work was done under contracts which included the foundations (27,500 cu.yd., Philadelphia, at average cost $19.80 per cu.yd.; 51,400 cu.yd., Camden, at average cost $16.60 per cu.yd.) and the furnishing of the anchorage girders and eyebars (2,300 tons), the total contract cost being $916,841.05 for Philadelphia and $1,217,811.58 for Camden. The granite masonry inclosure and floors which form the upper part of the anchorage, built later under a contract awarded to Keystone State Construction Co., included a total of 34,500 cu.yd. for Philadelphia and 36,100 for Camden. The contract cost of this work on the two anchorages, including additional foundations, steel work, elevators, equipment and interior finish, was $2,991,835.15.

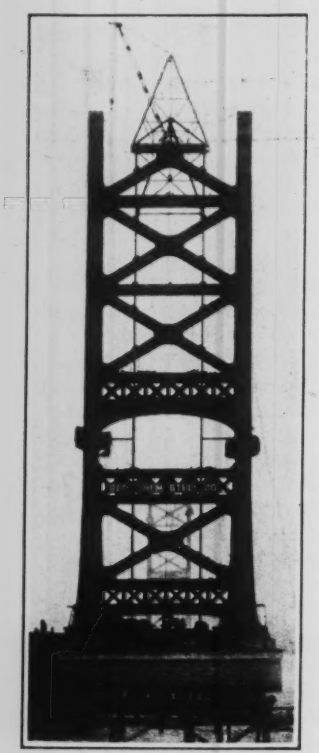


FIG. 8 — STEEL TOWERS ERECTED BY TRAVELING DERRICKS
View Feb. 21, 1924

Cable Anchors — After the adoption of general form and proportions it remained to decide between wire and eyebar cables. This question was studied by comparing a complete wire-cable design with three eyebar designs (with cable sags of 200, 220 and 240 ft.) at 40,000 lb. per sq.in. in the eyebars and 72,000 in the wire. Wire cables proved cheaper and were adopted.

Connection of the cables to the anchorage masonry is made by chains of eyebars connecting the strand shoes inserted in the end loops of the 61 strands of each cable to nine 42-in. box girders bedded in the concrete. The cables strands radiante from their fanning-out point to the strand shoes, set in square array, and thence their lines are continued by the chains radially to the piers in the anchor girders.

Where the cable fans out it is held by a cast-steel bell or toper collar (see detail on the insert plate), backed by a straight collar for further security against slipping. Above this point the cable continues upward at an angle of about 45 deg. to a saddle on a steel anchorage bent, is deflected here to about horizontal position, and then rises on the side span cable curve to the main towers, and so ultimately proceeds to the opposite anchorage.

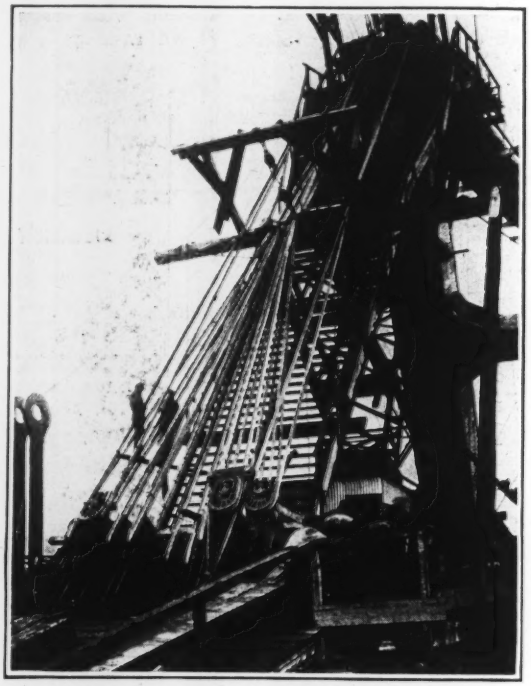
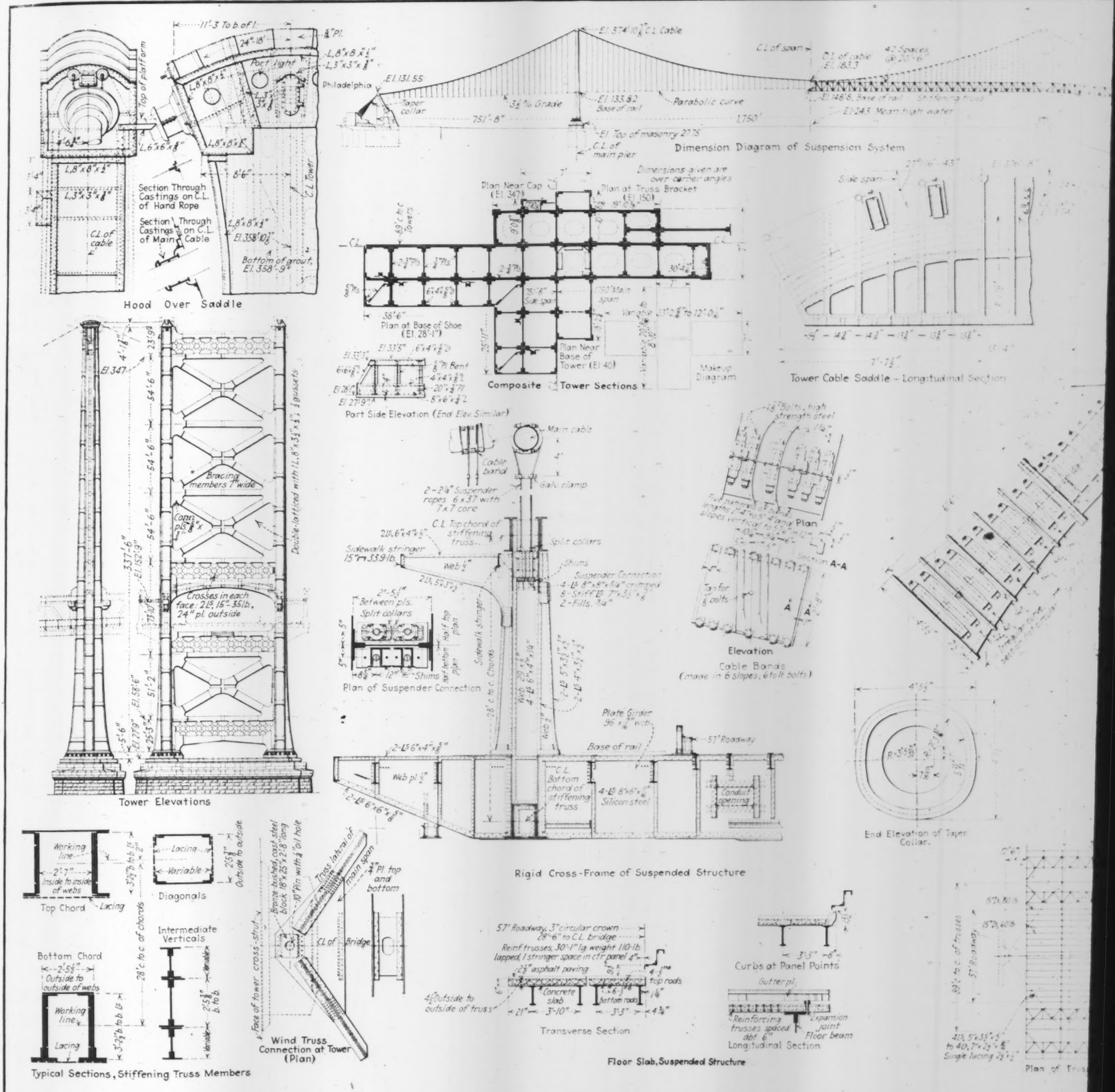


FIG. 9—HOW THE BRIDGE IS ANCHORED
Each cable strand is held by a pair of eyebars extending down to a group of girders bedded in the lower part of the anchorage concrete.

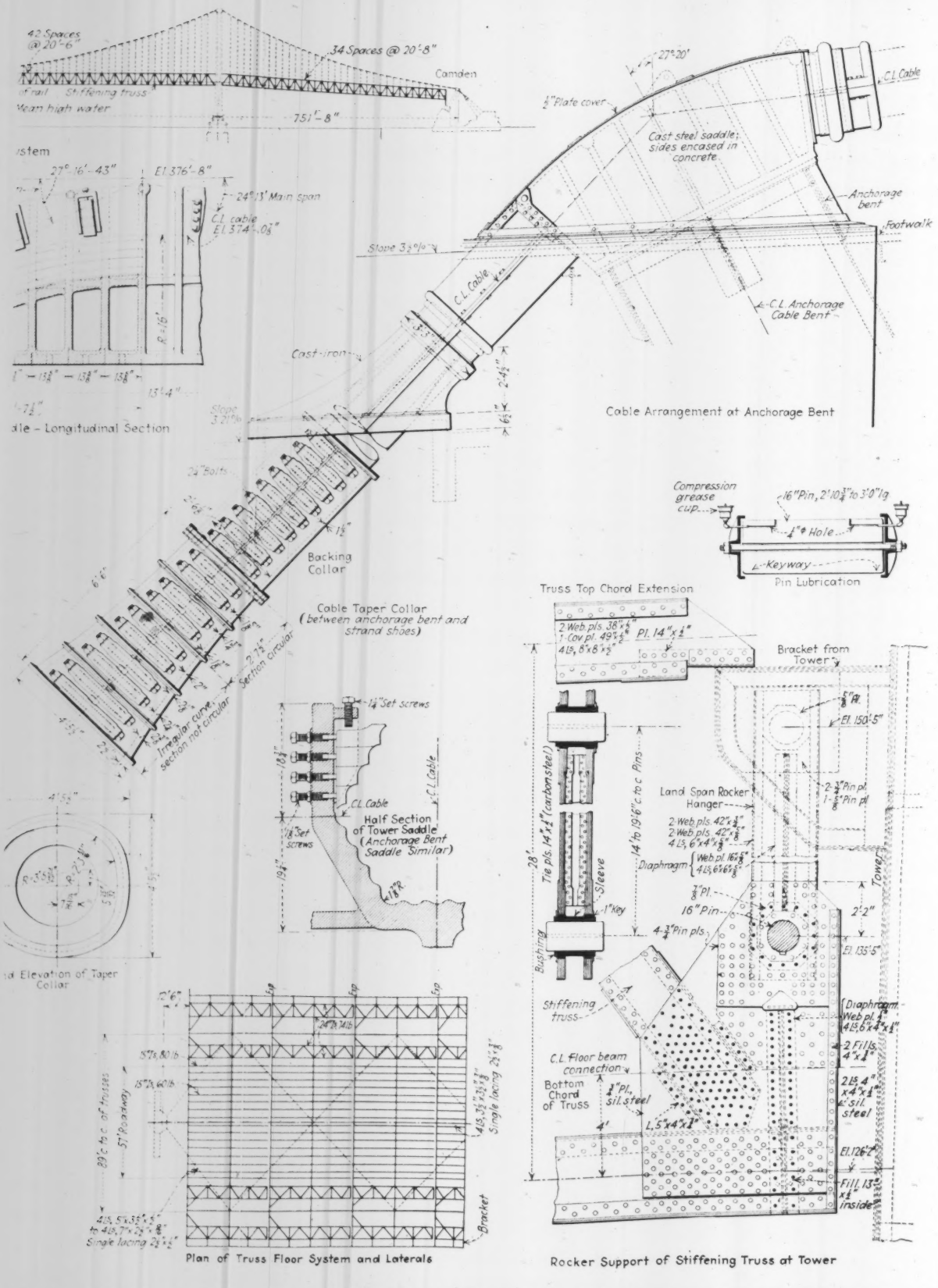
The anchorage bents, carrying a load about two-thirds as great as the main towers, consist of two silicon steel posts, about 7x8 ft. in cross-sectional dimension and 1,283 sq.in. metal section, 76 ft. long, built of three main longitudinal webs and three transverse staying webs. At their lower end they rest on cast-steel shoes, and on top carry a cast-steel saddle closely similar to the main tower saddle. The saddle is roofed with steel plates and its sides are incased in concrete.

Main Towers and Saddles—The tower design, which in a measure dominates the appearance of the bridge, involves two heavy vertical posts directly under the cables and a rigid bracing system of diagonals and struts detailed for massive appearance. Each of the two posts is of greater width longitudinally to the bridge than transversely, but in both directions has a curved tapering profile, which favors stability and permits obtaining the additional cross-section required by the larger bending moments near the base of the tower.

Each post of the tower carries a maximum vertical load of about 35,000,000 lb., of which 24,600,000 is dead-load; these figures are almost exactly equal to the corresponding horizontal pull components in one cable. In cross-section the post is cruciform. The large arm, parallel to the bridge axis, is composed of three $\frac{3}{4}$-in. to $1\frac{1}{4}$-in. webs $3\frac{1}{2}$ ft. apart and of width ranging from 12 ft. at the top of the tower (343 ft. above the masonry) to 38 ft. 8 in. at the base. These webs are connected at about $3\frac{1}{2}$-ft. spacing by vertical diaphragms of $\frac{3}{4}$-in. plate, and the middle three of these diaphragms extend outward to form the shorter arm of the cross, whose width ranges from 10 ft. to 26 ft. 1 in. Thus, the post consists of a main fore-and-aft member and


Hood Over Saddle
Section Through Castings on C.L. of Hand Rope
Section Through Castings on C.L. of Main Cable
Dimension Diagram of Suspension System
Composite Tower Sections
Plan at Base of Shoe (El. 28'-1")
Plan Near Base of Tower (El. 40)
Plan Near Cap (El. 347)
Plan at Truss Bracket (El. 150)
Part Side Elevation (End Elev. Similar)
Tower Cable Saddle - Longitudinal Section
Tower Elevations
Plan of Suspender Connection
Cable Bands
Elevation
Plan
Section A-A
End Elevation of Taper Collar
Rigid Cross-Frame of Suspended Structure
Typical Sections, Stiffening Truss Members
Diagonals
Top Chord
Intermediate Verticals
Bottom Chord
Wind Truss Connection at Tower (Plan)
Transverse Section
Curbs at Panel Points
Longitudinal Section
Floor Slab, Suspended Structure

Delaware River Suspension Bridge Between Philadelphia, Pa., and Camden, N. J.—Dimensional Drawing and



imensional Drawing and Details of Towers, Cables and Rigid-Frame Structure

minor transverse member integrated into a single cellular structure and further consolidated by horizontal diaphragms about 12 ft. apart. The latter have central manholes for access in inspection and painting, ladders being provided for the purpose. Three vertical splicing planes divide the tower cross-section into four construction sections, and transverse splices are 10 to 30 ft. long.

The towers are made of silicon steel (except for the transverse diaphragm and the sway-bracing members), to allow the use of a high unit stress corresponding to the desired flexibility of the tower under varying cable pull. They are seated on built steel shoes 5½ ft. high, resting directly on the masonry and held by twenty 3-in. holding-down bolts, which extend into the pier granite and concrete from 10 to 16 ft.

On the post is seated the cast-steel cable saddle, grooved to fit the hexagonal form in which the cable was laid up. The upper part of the cable periphery is held by profiled lugs screwed to the saddle sides. The weather protection of this tower top differs from that of the anchorage bent saddles, a complete plate-steel hood being built over the saddles and around the tower top (see detail on insert sheet).

The maximum cross-section of one tower post is 5,200 sq.in. Both towers together weigh 9,645 tons, to which is to be added 161 tons of saddle castings.

Cables—In the construction of the cables the same diameter and kind of wire were used as in most of the recent large suspension bridges: galvanized, hard-drawn steel wire, 0.196 in. in diameter after galvanizing, with ultimate tensile strength about 220,000 lb. per sq.in. Each cable consists of 18,666 wires (61 strands of 306 wires). The individual strands are each an endless wire (the separate reel-lengths of wire being spliced together by screwed sleeves) looped around the strand shoe at each end. The cable when completely laid was squeezed into circular shape by a power squeezer, giving it an outside diameter of 30 in. The cast-steel cable bands, constructed as detailed in one of the drawings, were clamped directly on the bare cable; between them a spiral wrapping of annealed galvanized steel wire was put on by a motor-driven wrapping machine under steady tension on the wrapping wire. The cables contain 6,780½ tons of wire including the wrapping.

At the anchorage bent saddles, where the cable section changes from circular to hexagonal and wrapping therefore would not give a fully tight protection, a shell cover is provided for protection. At the main saddles the wrapping finishes against the end grooves of special castings, bolted to the end faces of the tower hoods.

Two suspender ropes are looped around each main band, so that the suspender consists of four 2¼-in. ropes socketed to engage the upper ends of the stiffening-truss posts. Shims for adjustment and locking plates to hold the suspender sockets in place, are provided at the connection. These ropes have a strength of about 400,000 lb. each when tested in the straight length, and in excess of 380,000 lb. when tested over a 32-in. sheave (like a cable band groove), while the actual maximum load at any one panel point can never exceed 400,000 lb. on all four ropes.

Stiffening Truss and Roadway—The panel length of the stiffening trusses is 20 ft. 6 in. in the main span and 20 ft. 8 in. in each side span, which is the same as the suspender spacing. The trusses are shallow (28 ft. deep). Their chords and the end rockers are nickel steel, while web members and laterials are of silicon steel.

The truss system is continuous from tower to tower and from tower to anchorage, which construction was considered by the engineers to give the maximum economy, most effective stiffening, and least local stress and wear at hinges or the like. At the towers, the center span and side-span trusses are suspended by means of rocker hangers from brackets riveted to the tower posts; bushed and lubricated pins connect these hangers to brackets and trusses respectively. A similar rocker, in compression, supports the side-span truss on the base of the anchorage bent.

The maximum bending moment in one truss is about 200,000,000 ft.-lb. in the center span and 222,000,000 ft.-lb. in the side span, while the maximum shears are 1,263,000 and 1,682,000 lb. respectively. The total steel weight in trusses and floor is 18,700 tons, of which a little more than half is in the stiffening trusses.

Wind-stress transfer at the towers and anchorages is made by a jaw connection located on the center line of the bridge. Longitudinal movement is permitted by the jaw but lateral movement is prevented.

The floor consists of 8-ft. floorbeams between trusses, rigidly riveted to the truss posts (the shape of the three-member frame formed by the truss posts and floorbeams is shown in the cross-section of the bridge on the insert sheet) and prolonged outside the trusses by brackets carrying the outer tracks. Between these floorbeams are fastened 18-in. I-beam stringers 3 ft. 10 in. on centers, with expansion seats at every other panel point. The concrete floor slab of the roadway rests directly on these stringers. In view of the heavy load concentrations which a modern highway floor must be proportioned to carry a 30-ton truck with 15,000-lb. wheel loads and exerting a 50 per cent impact was contemplated—requiring a strong slab, while at the same time it was desirable to hold the dead weight to a minimum, heavy reinforcement and effective shear reinforcement were required. The main (transverse) reinforcement consists of "Rivet-Grip" trusses 4½ in. deep, set transverse of the bridge, 6 in. on centers on suspended spans and 7 in. on approaches. Longitudinally there are upper and lower temperature rods. A 1:1½:3 concrete, of about 2,700 lb. strength at 30 days, was placed around this reinforcement to form a 6-in. slab (1:2:4 concrete in 7-in. slab on the approaches). This slab was ultimately topped off with a 2½-in. sheet asphalt surfacing on the suspended structure, and with 3-in. granite block paving on the approaches. The sidewalks are floored with 3-in. concrete slab.

At alternate panel-points, where the stringer system has expansion seats, the floor slab and pavement are interrupted, and are retained by 8x3½-in. steel bulb angles set on the stringers transverse to the bridge, each angle being effectively anchored back to the concrete of its roadway section. Over the rocker connections at towers and anchorages, where large expansion movements occur, specially designed toothed-grid expansion joints allowing for about 12 in. of movement are provided. On the approaches a heavy sliding-plate joint is used, the plate seated on heavy iron castings.

[*The history of the planning of the Philadelphia-Camden bridge and the general design features by which the requirements were met as to the bridge itself and its approaches are given above.*

Part II of this article, to appear in a following issue, will describe the erection of the bridge.—EDITOR.]

Refuse Disposal Practice in Six British Municipalities

Recovery of Paper, Metals, Fuel and Other Utilizable Material and Burning of Combustible Residue in Heat-Producing Destructors by Five Cities—Use of Refuse for Land Reclamation

By John B. C. Kershaw
Consulting Chemist, Colwyn Bay, Liverpool, England

RECOVERY of salable material by picking from movable belts and by screening is a dominant feature of advanced city refuse disposal practice in Great Britain today. Incidentally this salvage work reduces the volume of material to be passed through the furnaces. At some plants, this lessening of the destructor burden is one of the main objects of screening; the screens take out large amounts of inert material that would otherwise appear as residue, increasing the labor at that end of the destructor and lessening the value of the clinker as well. In the more up-to-date plants, the clinker is reduced to granular form, graded in several sizes, and then sold for the manufacture of asphalt, mortar or cement, or used for these or other purposes by the municipality. At Woolwich, the borough itself undertakes the manufacture of a clinker asphalt for road-construction purposes, as is described further on.

The heat generated from the destructor furnaces is still being employed for steam-raising, in waste-heat boilers, as was the case ten years ago—but instead of running the destructors as adjuncts of electricity generating stations, or of other works, the tendency is to make them entirely independent of outside power. The whole of their machinery, therefore, is now being driven by electric power generated by the steam raised in their own waste-heat boilers.

Owing to the great increase in the cost of manual labor since 1918, the transport of the refuse and of all other materials inside the modern salvage and destructor works is carried on almost entirely by mechanical means. This change renders necessary the use of larger generating power units and many electric motors in the works. The design and operation of a modern salvage and destructor plant, therefore, have become much more of an engineering problem than they were ten years ago, when the refuse was merely shoveled into the destructor by hand labor and systems of mechanical and pneumatic transport were quite unknown in such plants. This article describes methods and plant now in use for dealing with some or all of the refuse of Birmingham, Glasgow, London (Westminster), Sheffield, Southport and Woolwich. Destructors are in use for the disposal of some of the refuse (chiefly unreclaimable otherwise) of all these places with the exception of Southport, which has abandoned its destructor and utilizes its refuse for the reclamation of low marsh lands for agricultural purposes. One other marked difference from American practice must be noted. In Great Britain, garbage, ashes, paper and miscellaneous dry wastes of all sorts are collected and disposed of together. Attention may also be called to the fact that the long ton of 2,240 lb. is used throughout this article. The populations (P) are estimated for June 30, 1923, based on the 1921 census returns.

Birmingham (P. 946,400) — In its Brookvale Road refuse, salvage and destructor plant, Birmingham possesses the best equipped works of its kind in Great Britain. The total cost was $480,000. The plant was opened April 9, 1924. It treats only a part of the refuse of Birmingham, the organic and remaining refuse going to the other destructor plants owned and operated by the municipality.

On arrival at the Brookdale Road works, the refuse is weighed, then passed on to a circular screen by an automatic feed, which maintains a uniform delivery. The fine dust and fine ash pass through these screens into enclosed storage hoppers, and are carried away from these by a pneumatic conveyor piping system to barges on the canal for transport to places where they can be used or dumped. Iron and other magnetic materials are removed during this screening operation by magnetic separators. The coarser material which is left on the screens is then delivered to an inclined conveying and picking belt, from which tin cans and other articles of value are removed by hand. The paper is carried away by air suction acting through adjustable hoods, which are placed at the extreme end of travel of the belt. Some of the light dust is also sucked away with the paper, and the two are parted in a newly patented form of separating chamber. The dust is returned to the fine-material hoppers under the first screen, while the paper is passed down chutes to a baling press located in the basement of the building.

The residue from all these operations is burned in a top-fed Heenan destructor. The resulting heat is used to raise steam for the power plant of the works. The destructor clinker is finally pulverized, screened and sold, in two or three sizes, for manufacture of cement, mortar and other purposes. Table I shows the working results for the year 1925. [A later installation at Birmingham, opened June 15, 1926, was briefly described in our issue of July 22, 1926, p. 157. —Editor.]

Glasgow (P. 1,051,300)—All the domestic and trade refuse of Glasgow, including that from slaughter houses, is treated, in the manner here described, at nine different centers. The refuse wagons on arrival at the works pass over the weigh-bridge, and are then hauled up an inclined roadway to the tipping floor. Here the refuse is raked out into a chute leading to a cone-shaped screen, revolving at about 12 r.p.m. The screen is provided at each end with 8-ft. rolled steel tires rotating on cast-steel bearing wheels. The drive is by rack and pinion. The effective length of the screen is 9½ ft. It has 1¼-in. meshes and a total superficial open mesh area of 90 sq.ft. The maximum amount of refuse which can be dealt with per hour is 15 long tons.

The material under 1¼ in. which passes through the screen forms 80 to 85 per cent of domestic refuse, and drops into a mixing machine underneath, which also receives a quantity of sewage from a tank placed above. Dry sweepings from paved streets are also passed through this screen into the mixer. The whole, after being thoroughly incorporated by means of revolving blades, is discharged into a railway car on the siding

below, and is either dispatched to farmers as "prepared city manure," or is carried by rail to the cleansing department's tips in the country.

The rougher portions of the refuse, which cannot pass through the screen, are delivered from its bell-shaped mouth on to an endless belt, from which iron, tin cans, bones, etc., are picked off for sale. The tailings, chiefly light useless material, fall into a range of top-fed hand-fired destructor furnaces. The residue or clinker is fed into a breaker from which a bucket elevator raises it to four perforated cylindrical revolving screens, where the material is graded into four sizes ($\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ and 1 in.) and tailings. The material finds a ready sale for making concrete, etc. Prior to 1896 it was dumped on land at a cost of 25c. per long ton; but now a good revenue is derived from it. The cans are de-tinned and de-soldered in a small furnace, and are then compressed by hydraulic power into 112-lb. billets, and sold as scrap iron. Considerable revenue is derived from the salvaged materials (Table II). This system of screening and converting the finer refuse into "prepared manure" has been in use in Glasgow for forty years. The method of salvaging all other salable materials has been in operation for fully twenty years and has yielded a total revenue of over $633,600, making a grand total of $1,920,000 revenue since the respective schemes were introduced. [This appears to be gross operating revenue.—EDITOR.]

REFUSE SORTING CONVEYOR BELTS AT BROOKVALE ROAD DESTRUCTOR, BIRMINGHAM, ENGLAND

London (Westminster) (P. 140,430)—The city of Westminster's Ebury Bridge Road salvage and refuse destructor was opened May 3, 1923. Its capacity is 100 long tons per day, and the methods of treatment and separation follow very much the lines of those described under Birmingham. The special feature of the Westminster works is the Copëe washers which recover the coke and other combustible matter from the tailings of the picking belt. These washers are of the type used for coal-washing, and the pulsating action of the water is obtained by air pressure. The smallest and the intermediate screenings go to washers 1 and 2 respectively and the coarsest material or tailings are dealt with as described later. In both washers the lighter combustible material is separated from the heavier water flotation, chuted to a draining tank, drained and dropped to a bunker, from which it is again dropped to motor trucks to be removed for sale as fuel. The heavier materials from each washer—clinker, glass, stone, etc.—are raised by an elevator and discharged into a bunker for further treatment by hand picking and sorting or for loading direct into motor trucks for dumping. Washer 2 is adapted to handling coarser material than 1. The coarsest material of all, or tailings delivered from the end of the rotary screen, is chuted to a swing-hammer pulverizer, driven by belt and shafting at a speed of 1,000 r.p.m. This reduces it to a very fine powder, and it is then sold as a manure. The non-combustible material from the washers is either sorted by hand picking or dumped.

Electric energy is used as motive power throughout the works but is purchased, the fuel recovered at these works being sold as such.

Sheffield (P. 524,200)—The dry refuse is delivered by electric collecting vehicles into a 500-ton bunker, from which it is lifted by electric grabs and dropped into feeding hoppers. From these it is moved by feed conveyors to ten rotary screens which separate it into four classes of material: (1) Dust passing through $\frac{1}{4}$-in. mesh; (2) fine cinder, $\frac{1}{4}$ to $\frac{1}{2}$-in.; (3) coarse cinder $\frac{1}{2}$ to 2-in. and (4) tailings, which are delivered to the picking belts.

The dust is a useful fertilizer, and considerable quantities are supplied to agriculturists. The fine cinder is disposed of as a fuel for furnaces, suitably arranged to deal with such fine material, or is briquetted for domestic use. The coarse cinder passes through washers, which separate the lighter combustible from the heavy incombustible matter. The washed combustible material is passed to bunkers, supplying underfed stokers connected with Stirling water-tube boilers. No coal is purchased for this plant, the boilers being fed solely with fuel extracted from the refuse—as is the case at all the other destructors here described except the one at Westminster. The heavy incombustible is dumped. Three 250-kw. generating sets provide sufficient electric current not only to run the works, but also to charge the batteries of the electric motor trucks used for transporting the refuse. A garage for accommodating 75 of these electric vehicles has been erected. The total cost of the works and garage at Sheffield has been over $1,000,000.

From the tailings, useful material, such as tin cans, rags, paper and bones, are picked off, and the residue is burned in destructor furnaces. Tins are baled and supplied to steel makers; the paper goes for remanufacture; rags are washed and sterilized and sold; and bones are degreased and ground into bone manure.

An income of about 60c. per ton of crude refuse dealt with is obtained from the various salable commodities. The cost of dealing with the town's refuse has been much reduced since the starting up of this plant, which is capable of dealing with 500 tons of dry refuse per day.

Southport (P. 72,410)—Since 1914, this residential and seaside resort has cut its formerly high unit cost of refuse collection and disposal to one of the lowest in England, says H. M. Webb, borough deputy engineer and surveyor, in a paper read before the Institute of Cleansing Superintendents, in June, 1925. This has been done by gradual adoption of motor trucks for transporting the refuse to the point of disposal, after a full horse-drawn load has been obtained—and by the substitution of land reclamation for destructors. The shape and low population density of the borough led to the use of the transport method just mentioned, which is known locally as the "container" system. The borough stretches along the sea for 8½ miles, and back from the water front 2 miles. The population density averages 5.6 houses per acre, with 15 as a maximum. Even the working-class houses are nearly all semi-detached. The wagon-boxes or "containers" are low-sided and have a capacity of three tons each. When loaded, the wagons are drawn to transfer points, and the boxes are shifted to the motor trucks, by means of a winch operated by the engine of the truck. The loaded boxes are first raised from the horse-drawn wagon to a lifting frame. The frame and its load are then lifted and the container is moved over and lowered on to the truck.

Woolwich (P. 140,000)—Clinker utilization is the chief feature of the Woolwich destructor installation. Besides the more common brick and sidewalk or footpath slab-making appliances, there is an elaborate plant for treating the clinker and concreting it into clinker asphalt for surfacing and repairs. The steam raised by the destructor heat is sold as such, and paper, rags, bones, heavy metal and tin cans are recovered from the picking belts in the usual manner and sold.

The clinker asphalt plant comprises an enclosed and self-contained system of grinding, separating, drying, weighing and mixing machinery, and produces an aggregate of crushed and graded clinker, which is mixed with bitumen (or some other suitable binder) ready for laying on the road. This plant has been in actual service for a considerable time, and the manufactured material has been used for laying one of the main arterial roads running through the neighboring township of Eltham, which is now incorporated in the Borough of Woolwich. With regard to the possible area of supply, when the manufactured material is transported in 5-ton loads, it is found that the drop in temperature ranges from 1 to 1½ deg. F. per mile. This signifies that the effective area of supply is a distance of 49 to 50 miles from the place of manufacture.

CLINKER FLOOR OF BROOKVALE ROAD DESTRUCTOR

The clinker is taken from the destructor furnaces to the clinker asphalt plant in the hot state, and before grinding it is passed over an electro-magnetic separator which removes iron and other magnetic material. The crushed clinker then passes through adjustable screens, designed to give any predetermined grade of size from ⅛ to ½ in. The screened material is stored in two large hoppers, with a combined capacity of 70 long tons. The smaller of these hoppers stores the finer material used exclusively for road surface work, and the second stores the larger material used for road foundations.

TABLE I—OPERATIONS OF THE BROOKVALE ROAD REFUSE SALVAGE AND DESTRUCTOR PLANT, BIRMINGHAM, ENGLAND

During the calendar year 1925, the plant treated 31,633 long (or 35,429 short) tons of garbage and refuse, forming only part of the refuse of Birmingham.

		Total	Per Long Ton
Operating costs		$41,164	$1.30
Operating income			
Crushed clinker	$8,419		
Baled scrap and tin cans	5,356		
Baled paper	940		
Metals	884		
Bottles and jars	662		
Bones	580		
Light scrap metal	302		
Rags	216		
		17,361	0.548
Net operating costs		$23,803	$0.752

TABLE II—OPERATIONS OF ALL THE GLASGOW SALVAGE AND DESTRUCTOR PLANTS

During the year ending May 1, 1925, the nine salvage and destructor plants treated 347,180 long tons, equivalent to 388,841 short tons, of garbage and refuse.

		Total	Per Long Ton
Operating costs		$244,905	$0.705
Operating income			
Slaughter house manure	$19,920		
Baled scrap and tin cans	17,323		
Prepared manure	13,526		
Trade refuse	11,332		
Clinker	6,144		
Waste paper	1,996		
Sundries	326		
		$70,567	0.203
		$174,338	$0.502

Each hopper is provided with a mechanically-controllable discharge, which allows the crushed clinker to fall through an inclined chute to the boot of a second elevator, which raises it to the inlet of a rotary heater. This heater is provided with deflecting vanes, so spaced as to expose the largest possible surface of the crushed clinker to the destructor gases and to ensure the clinker being raised to the required temperature before being passed into the weighing bin, which feeds the mixers. When the required amount of clinker has been collected in one of these weighing bins, it is automatically discharged into a paddle-mixer placed immediately beneath it, and the necessary amount of bitumen or other binding agent is discharged simultaneously from a measuring tank, placed alongside the weighing bin. The clinker and bitumen are incorporated thoroughly in the mixer, and are then discharged into a steam-jacketed storage hopper, kept hot by superheated steam at temperatures ranging from 400 to 500 deg. Fahrenheit.

No operating figures for this plant are yet available but at a later date the writer hopes to be able to give further information and costs, together with the borough surveyor's report upon the durability of the roads which have been surfaced with this clinker asphalt.

Water Inlet, Screen and Aerator for Liverpool Water Filters

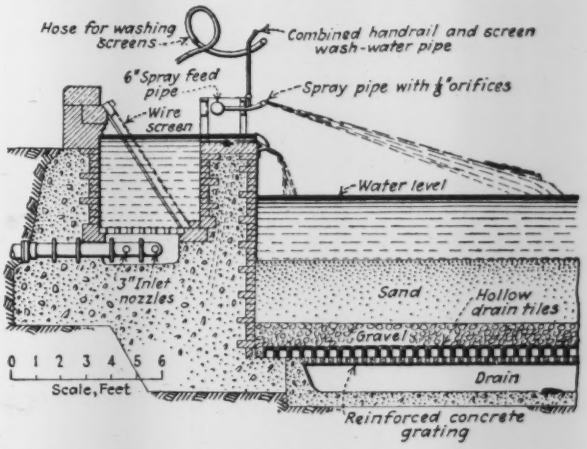
New Slow Sand Beds May Be Supplied With Water in Thin Sheet Over Weir or Through Spray Orifices Under 40-lb. Pressure

THE INLETS to the three newest slow sand filters of the water-works of Liverpool, England, are so designed as to give a choice between delivering the influent in a thin sheet over a long weir and discharging it as fine spray from hundreds of small orifices in a pipe placed above the weir. The arrangement has not been fully tried out, states London *Engineering* in an article on the new filters (July 30, p. 123), which goes on to say: "The primary object of aeration at this plant is to relieve the filter beds by pre-oxidation of any organic matter present in the water and by converting ferrous into ferric salts." A reduction of the color of the water is also anticipated. The untreated water has a color of 6.5 "as measured by the tintometer." This is reduced to 3.5 by the old filters and to between 3.5 and 3 by pre-aeration and the new beds.

The three filters with the new type of inlet were put in use in October, 1925. Like the 12 earlier ones, each has an area of 0.8 acre (180x198 ft.) and is operated at a rate of 2.4 U.S. m.g.d. With one bed out of use, this gives a combined capacity of 33.6 U.S. m.g.d., which is about 65 per cent of the daily supply of Liverpool. The filter beds are located at Owestry, 18½ miles below Lake Vyrnwy and 50 miles above the Liverpool service reservoir at Prescot.

The character of the Lake Vyrnwy water before treatment is described by *Engineering* as "excellent," with a color of "only 6.5 as measured by the tintometer," but in the pipe lines above the filters the water leaves a "deposit, which is soft and slimy." This is removed once a year, a brush being driven through the pipe by the water pressure.

The design and operation of the inlet of the new beds



INLET, SCREEN AND AERATOR FOR SLOW SAND FILTERS, LIVERPOOL, ENGLAND, WATER-WORKS

The inlet channel and the pipe feeding the spray nozzles extend along the side of each bed. There are 540 spray orifices, about ⅛ in. in diameter, 4 in. c. to c., to each bed.

(see cross-section) are as follows: The channel, screen, overflow weir and aerator pipe extend along one of the 198-ft. sides of each bed. The channel inlet is fed by three 6-in. pipes, entering at right angles, and discharging horizontally in both directions through two 3-in. outlets on each side. The discharge is into a trough in the bottom of the inlet channel. The water rises through a grid placed over the trough and passes up through an inclined 40x40-mesh gauze screen with an effective area of 912 sq.ft., and over a weir onto filter bed in a thin sheet. The screen is in sections, each "held in position by a single quick-release clamp." On emptying the inlet channel, the screens may be washed in position by means of a 1-in. hose, fed from a 1-in. pipe, which also serves as a handrail to the footwalk over the inlet weir. The wash water is wasted through a valve at one end of the channel.

The aerator delivers 540 spray jets through as many gun-metal orifices, each about ⅛ in. in diameter, 4 in. c. to c. Under the normal pressure of 40 lb., the water travels through the air for 12 ft. before it reaches the water surface above the filter bed. The orifice pipe is fed by branches from a 6-in. supply pipe controlled by a valve.

The article in *Engineering* mentions the spray aerator and the thin sheet discharging over the weir as alternative filter inlets and indicates that the entire arrangement is still under trial. It says nothing of the possibility of operating the two in combination nor of any arrangement for screening the water before it is discharged through the aerator orifices.

The new filters were built from designs by **Col. J. R. Davidson**, city water engineer of Liverpool.

Construction Work on a Chinese Railway

Grading, Tunnels, Bridges and Culverts—Tunnel with Roof of Concrete Blocks and Walls of Varied Types —Riprap on Fills Along River—Compressed-Air Foundations

By H. Stringer
Shanghai Waterworks Co., Shanghai, China

HEAVY grading, river bank protection, tunnels, bridges, caisson foundations and numerous waterway openings were features in building the 67-mile Chaoyang branch of the Peking-Mukden Ry., in China, and particulars of this construction work may be of interest to American engineers. The first 33 miles, built in 1921, traversed fairly easy country; but the 37 miles from Y-hsien to the terminus at Peipiao traversed country of some difficulty. The latter section was completed in 1924.

As the line was expected to handle 6,000 tons of coal daily and also a considerable grain traffic, grades were limited to 0.74 per cent, and curves to 3½ deg., the maximum grade being reduced to 0.65 per cent on all curves. The rapidly increasing cost of maintenance in China was a factor in selecting these limits.

Track is laid with 30-ft. 60-lb. rails removed from the main line, with 14 Oregon fir ties to a rail length. Except for the Ta Ling Ho bridge, the work was completed ahead of tracklaying. All plant for the tunnels and all cement for important structures was hauled by native carts over the earth roads. Work on this bridge is shown in Figs. 1 and 2.

Surveys—The country being open and free of brush, a traverse survey was made, but with a plane-table survey run concurrently to put in detail and as a check. The survey for the paper location was made with 10-ft. contours where the ground was very broken. Here the usual traverse was run and stations checked by leveling. contours were located from these stations by level and the positions picked up by tachometer and plotted in the field. Later, as the survey staff was depleted for construction, the method of spot leveling was adopted, with tachometer only. As a number of students were sent for training in survey work the spot leveling was again extended to include the plotting of contours in the field.

In the latter case the levels of each station on the traverse were sent back to the plane-table party, whose duties combined putting in the topography and plotting contours. The contours were located by hand level on selected lines radiating from the traverse station, distances being fixed by tape. The traverse stations were a maximum of 700 ft. apart. If the connection of the contours taken from each station was not sufficiently represented by sketching on the ground, an intermediate station was put in by plane table.

The scale was 2,000 ft. to the inch for reconnaissance and 200 ft. for paper location. Much of this work was done in winter, with the ground frozen to a depth of 4 ft. An iron peg was used first to make a hole for the wooden pegs or stakes, and where final pegging had to be done, only points of intersection and stations at 2,000-ft. intervals on long tangents were marked permanently, using stones about 8-in. square and 3 ft. long. Arrows only were used as temporary marks for intermediate stations, as these could be driven into the soft 6-in. layer of soil overlying the frozen ground.

Drainage and Waterways—The accompanying table was used as a general guide for culverts, but was widely departed from if inspection of the drainage area was thought to demand it. Complete drainage area plans on a scale of 2,000 ft. to the inch were made for the smaller streams, up to about 4,000 acres in extent. For culverts up to and including single 6-ft. openings, the Meyer formula was used, with the Talbot formula for larger culverts. In these, which are both for steep and rocky country, C is in acres: Meyer: $A = 4\sqrt{C}$; Talbot: $A = 4\sqrt{C^3}$.

FIG. 1—PLACING AN AIR LOCK: TA LING HO BRIDGE

Where drainage areas were too large to measure, flood level slope and cross-sections were taken, and with an assumed constant the Kutter formula $V = 47\sqrt{RS}$ was used to calculate flood velocity. The amount of backing up which was to be expected from constriction of channel up to as much as 50 per cent was investigated in the manner described in Kempe's "Engineer's Year Book," p. 512, 1921 edition. Restriction to over 50 per cent was not considered advisable. Wherever drainage areas were measurable and demanded openings of over-culvert size, the Kutter formula was checked against the quantity derived from drainage area considerations only, taking runoff at 100 per cent and rainfall at 1 in. an hour. This rainfall was not excessive, being exceeded in one or two cases. Rough estimates of the amount of runoff actually occurring in areas with bare rocky upper slopes and valley bottoms planted with

millet, indicated about 77 per cent after thorough saturation. This figure was based on weir calculations.

Grading—On fills, the subgrade width was 16 ft. with first class rock, 18 ft. with surface or inferior rock and 20 ft. with earth. Side slopes were 1 on 1½ for earth, and the angle of repose for rock never exceeded 1 on 1¼. Cuts were made of ample width on account of ice and heaving from frost. In sound rock they have 18-ft. subgrade and slopes of 1 on 1¼. In this broken country it was economical to run many of the cuts to fills, using portable track in 16-ft. lengths of 30-in. gage, with 16-lb. rail and steel ties. The cars were of 18 cu.ft. capacity. Rock in cuts often compelled the half-borrow, half-haul method of building fills.

River Bank Protection—Two miles of heavy protection were required where the line was located along the bed of the Ta Ling River, which is a considerable stream in times of flood. Rough gagings during the high flood of August, 1923, gave the following data: Width, 2,900 ft.; depth, 12 to 15 ft.; velocity, 14 ft. per second; estimated discharge, 180,000 cu.ft. per second. The protection adopted, shown in Fig. 3, had been tried on a smaller scale on the main line.

The rock used was a hard black basalt which outcropped along the river. In one quarry this stone had a columnar structure and could be quarried almost without the use of powder in pieces 10 cu.ft. in size and lengths up to 6 ft. For handling this heavy stone where there was water to contend with, the berm *A* was completed first with small stones weighing from 100 to 140 lb. and a temporary track was laid on this for dumping the heavy stone for berm *B*. The light weight of stone for berm *A* was not advocated, but was necessitated by labor troubles and lack of time, since it was imperative to get the line protected before the rainy season, as the earthwork of the fills was carried on simultaneously with the slope protection.

Tunnels—There are two tunnels; one of 383 ft. was in hard rock requiring no lining; the other was 3,894 ft. long in a friable horizontally bedded green sandstone requiring lining to all the arch and a considerable part of the side walls. Both tunnels were driven by the top heading (Belgian) method and in the longer tunnel this proved its great advantages (apart from its suitability on other counts) for a country where expert timber men are not available. The top heading, about 8x8 ft., was widened out to full size to admit of turning the arch, for which benches were excavated 3 to 6 ft. deep. The arch was lined with precast concrete blocks (1:2:4 mix), this being the only feasible way of ensuring a sound job and proper thickness of lining, in the absence of suitable bricks. On completion of the arch, the sills were underpinned in 6-ft. lengths.

The question of sidewall thickness was a continual problem, owing to the varying character of the rock. Where the rock was disintegrated into what had the appearance of a hard clay the lining was 2 ft. of 1:3:6 concrete. Where the rock was rotten and showed signs of weathering badly, the lining was 18 in. of 1:4:8 concrete, except in very wet places where the 1:3:6 mix was used. For 60 per cent of the length of the tunnel, where the rock was sound but its weathering qualities were open to doubt, pillars 18 in. thick and 6 ft. wide were inserted, the rock surface between pillars being cut back to admit of a plaster at least 2 in. thick. These pillars, of 1:3:6 concrete, were 12 and 9 ft. apart for arch sills 6 and 9 ft. below the springing line, respectively. The tunnel section is shown in Fig. 4.

Tunnel drainage is a difficult question in a country where 40 deg. of frost is possible and a zero temperature is usual from December to March. This difficulty was solved temporarily by having doors of matting at each portal, which were kept closed between trains. As a tentative permanent solution, a concrete, slab-covered side drain was adopted which drained to catch pits at the north portal, where pipes below the frost line led to a large blind well at the mouth of the approach cutting. Fortunately the amount of water in the tunnel was not great.

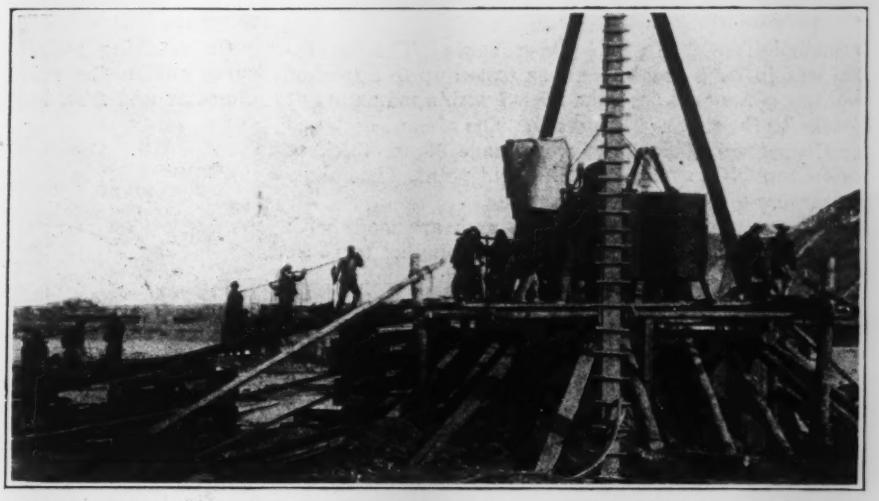


FIG. 2—SINKING A BRIDGE CAISSON, CHAOYANG BRANCH, PEKING-MUKDEN RY.

For the longer tunnel, there were three shafts served by steam hoists and double cages which handled the 18-in. dump cars used between the shafts. At the portals, 24-in. gage cars were used. All spoil was hand hauled to the dumps. Drilling was done entirely by hand, though steam drills and steam-driven fans for ventilation of headings were offered to, and refused by, the Chinese contractors. Dynamite, fired by fuse, was used to a large extent, as the amount of water present precluded the use of native powder, which was used for rock excavation wherever possible. Work was carried on night and day. The headings, begun in June and July, 1922, were holed through on Feb. 24, 1923, and the tunnel was opened to traffic Nov. 24. The only serious mishap was the bursting of a heading drain dam in the south approach cut during a torrential rain; this caused the flooding of the tunnel as far as the second shaft and delayed work for a fortnight.

Bridges and Culverts—There were 118 culverts and 29 bridges on the 37-mile section. Arch culverts were used extensively and the majority of these were of concrete. In the neighborhood of the coal mines, a hard

burned shale brick was obtainable and was used for arches, in conjunction with coursed rubble sandstone or limestone.

Heavy calls on the railway bridge-works for steel structures in renewals and double tracking entailed the adoption of arches in plain concrete for a viaduct of eight spans of 30 to 34 ft. crossing a gulley at a max-

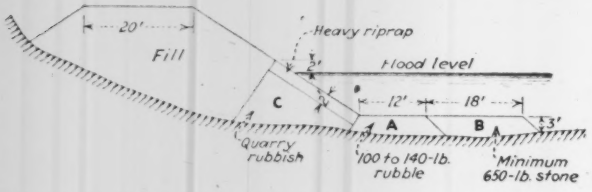


FIG. 3—PROTECTION OF FILL ALONG RIVER
Top of berm *A-B* is 3 ft. above ground or 18 in. above low-water level.

imum height of 55 ft. on a 3-deg. curve. The foundation was in hard clay which was tested up to a load of two tons per square foot and loaded with a maximum of 1½ tons in the finished structure. The arches, designed for Cooper's E-50 loading, were made 30 in. thick at the crown, with 3 ft. of cover at that point. The abutments were of the buried-wing type.

Four contraction joints in each arch are made with oiled paper, as shown in Fig. 5, and similar to those in the culverts.

Above the springing line, each arch was of 1:2:4 concrete, except that the key block was of 1:1:2 mix to admit of striking centers after seven days. Over the joints a *V*-shaped notch with 1-in. sides was cut in the concrete and filled with pitch. Elsewhere, the arch was waterproofed with a rich mortar worked until it had nearly set. All concrete was hand-mixed and that for the piers was carried up on inclined gang planks (Fig. 2). The arches were all cast from one end, the raw materials being carried up and mixed on platforms built over the haunches and moved forward as the arches progressed. The arch centers were supported on corbels 12 in. thick (Fig. 5), reinforced with pieces of 60-lb. rail 4 ft. c. to c., the spacing of the arch centers. Four sets of centers were used and no center was struck, no matter what the age of the arch concrete, until the two arches ahead had been keyed in. The centers were supported on hardwood wedges 2 ft. long and 8 in. wide, with a 2-in. taper on a minimum thickness of 2 in.

Up to springing level, the placing of the concrete was done by contract; above that point it was done by day labor, about 140 coolies and 20 carpenters being employed continuously. The pouring of concrete was carried on without interruption between arch joints and the time for pouring an arch was 3½ days.

Foundations—For the 30-ft. arches, foundation wells were largely employed, as the streams were full of boulders and unsuitable for piling. As these streams were dry during winter and early spring, the wells were put down to a safe foundation with the use of 4-in. barge pumps only. Such sinking was carried to a maximum depth of 22 ft. These wells were arranged as in Fig. 5. In general, two sizes of wells were used, 9 ft. internal diameter under the piers and a combination of 9-ft and 6-ft. wells under the abutments. They were lined with 1:2:4 plain concrete 1 ft. thick, the bottom 3 ft. being widened out to 15-in. thickness with a 45-deg. cutting edge.

The lifts put on, as sinking proceeded, varied from 3 to 9 ft. No trouble was experienced from excessive leakage or cracking. On reaching a satisfactory bottom, the wells were sealed off under water with a 2 ft. thickness of 1:2:4 concrete. When this had set, the well was baled out and filled to the footing level with 1:4:8 concrete.

Wells were also adopted in three cases where under low water conditions water was flowing on the surface to a depth of about 2 ft. The river beds were of gravel and sand in layers mixed with large boulders, overlying a rock bed of hard basalt at depths of 13 ft. and 15 ft., except that in one case no rock was found. Steam pumps were used for unwatering, and the direct-driven 6-in. centrifugal pump was the most satisfactory on account of its lightness. These pumps were mounted on two 12x12-in. timbers, bolted together and spanning the wells.

On reaching rock, the surface was cleaned and a sump cut in the middle. A wooden drum 4½ ft. in diameter and 2 ft. high was then sunk and a concrete

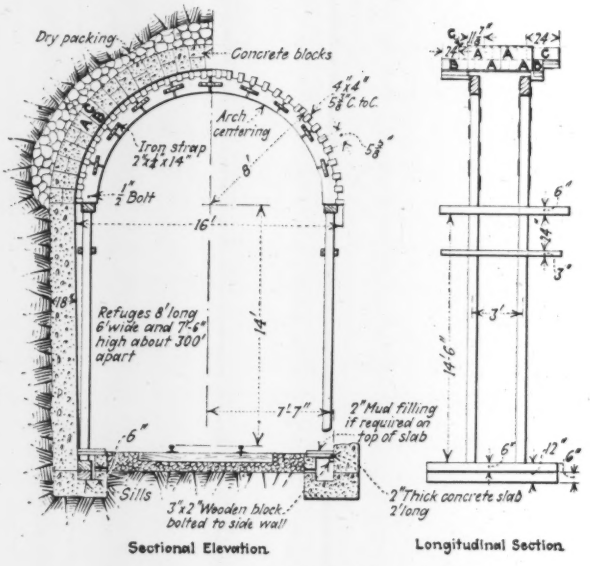


FIG. 4—NAN LUNG TUNNEL; CHINA

sealing layer for the edge of the well was placed under water between the well shell and the outer surface of the drum. This sealing layer of 1:1:2 concrete was in some cases tight enough to admit of baling out the well and cutting out a clean key of rock 4½ ft. in diameter in the center of the well; in other cases it was necessary to put back one pump while cutting this key. The key was then sealed with concrete under water and the well filled with 1:4:8 concrete to footing level.

Pier wells were tied together with a footing 4 ft. thick, reinforced with rails. Where it was not possible to sink this with sheeting or horizontal planking in the usual way for these small depths of about 5 ft., a rectangular concrete caisson was made, 1 ft. thick and reinforced with cement-drum strips 4 in. wide, or with bamboo. These footing caissons were 34 ft. long by 18½ ft. wide, and were stiffened centrally by two short beams 12 in. square at the top and bottom of the caisson.

Ta Ling Ho Bridge—The biggest bridge was that crossing the Ta Ling Ho, at Mile 59, at a height of 32 ft.

above low water, which is about 4 ft., increasing to some 16 ft. in depth, in floods. The river bed was 3,300 ft. wide and it was decided to use sixteen 100-ft. spans. With the exception of the wings of the sheltered south abutment all the foundations are on steel caissons sunk by compressed air. This work is shown in Figs. 1 and 2. The caissons were elliptical in shape, with a

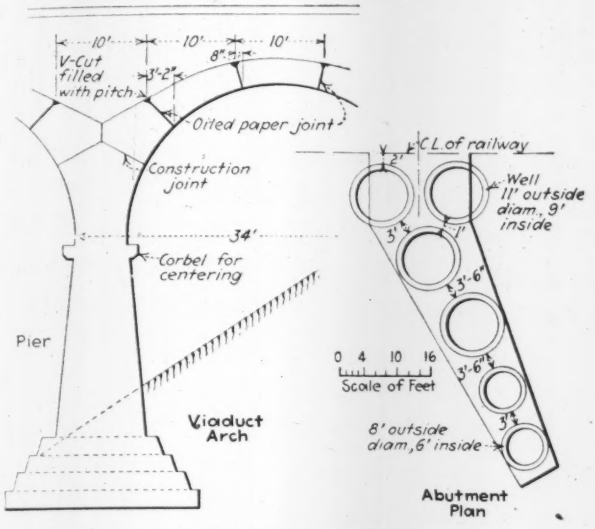


FIG. 5—CONCRETE BRIDGE WORK
At left, arched viaduct, note contraction joints. At right, plan of foundation piers for abutment.

base area of 228 sq.ft. and a working chamber 7 ft. high, in which six men could work with comfort. Their weight was about 9 tons unfilled, the skin filling being of 1:2:4 concrete. Borings indicated silt and sand of varying coarseness over a thick bed of very hard clay, and the caissons were sunk about 10 ft. into this clay.

The two houses for air compressors and engines were built of 2-in. plank covered inside with straw matting and papered at the joints. This means was taken to exclude the fine silt of the river bed, which the slightest breeze raised in clouds, while the winter wind storms masked the whole countryside in red-brown dust fog. For the same reason the air intake of the compressors was placed inside the engine house. While this had the disadvantage of causing occasional freezing up of the air intake tees to the air locks, it was preferable to damaged compressors. The main 2½-in. air line was 15 to 20 ft. from the bridge center line and was connected to the air locks with armored rubber hose. Pressures never exceeded 20 lb. per square inch and not more than three caissons were under air at one time.

Railway traffic was carried across the river on a temporary pile trestle having 42 spans of 12 ft., about 100 ft. downstream from the permanent center line.

The construction scheme aimed at getting all the sinking done in the low-water channel, about 500 ft., during the winter, when the river was frozen to a depth of at least two feet, capable of sustaining easily a 4-ton air lock. Caissons unloaded onto the ice were hauled to the pier sites and erected on prepared islands, each built of a rubble shell with a heart of small ballast and mud. After being sunk empty to water level, the caissons were filled with the first lift of concrete to 2 ft. above the top of the working chamber preparatory to air-sinking. Above low water they were erected in holes dug to the ice level. Subsequent lifts on the caissons were 8 ft. high.

The normal rate of sinking in sand or coarse gravel, without boulders of such a size as to necessitate the use of the man lock, was 8 ft. in 24 hours. In the hard clay this fell to 1½ ft. The only serious difficulty encountered was the jamming of most of the caissons after penetrating about 5 ft. into the clay, which may have been due to swelling of the clay and was overcome by weighting the caissons with about 30 tons of rails and then removing the pressure as rapidly as possible.

DESIGN DATA FOR SEMICIRCULAR ARCH CULVERTS

Culvert Diam., Ft.	Culvert Area, Sq.Ft.	Drainage Area, Acres	Culvert Diam., Ft.	Culvert Area, Sq. Ft.	Drainage Area, Acres
3	7.78	3.78	8	70.14	289.30
4	17.55	19.25	10	96.30	441.40
(2) 4	35.10	77.00	12	125.57	628.30
6	36.86	84.92	15	196.38	1,143.80
(2) 6	73.72	309.00	(2) 15	392.76	2,903.00

Protection work for the major bridges was a heavy item. Where the opening was restricted, the approach banks were riprapped to 2 ft. above the expected new flood level and a berm of heavy stone provided, as in the bank protection work previously described. The berm of heavy stone was 24 ft. wide at the Ta Ling Ho bridge and 12 ft. in the smaller bridges. Further, at all the larger bridges, upstream and downstream training banks were provided to throw eddies away from the abutments. Upstream training banks were made at least a span and a half in length; those on the downstream side had a minimum length of 50 ft. These banks, raised about 5 ft. above expected flood level, were built of first class material heavily riprapped and provided with an apron of heavy stone 5 ft. thick.

This railway work was under the general supervision of W. O. Leitch, senior district engineer, and L. J. Newmarch, general manager and engineer-in-chief of the Peking-Mukden Ry. H. Farrant was resident engineer until 1922, and H. Stringer until April, 1924; B. L. Jacobs, A. H. Douglas and K. S. Wang were assistant engineers. In addition, there were eight cadet engineers and two student engineers.

Repairing a Drawbridge Bearing

An error made in the erection of the Wabash R.R. 168-ft. bascule bridge over the Rouge River, near Detroit, had troublesome and costly results. In the hurried work of completing the structure to permit resumption of railroad traffic, the sleeve on a pin in one of the compression members or links of the counterweight system was placed upside down, so that the oil hole was on the side opposite to the oil grooves in the sleeve, thus preventing proper lubrication. Although this bridge was built in 1922 (*Engineering News-Record*, March 2, 1922, p. 363), it was not until February, 1926, that trouble developed in the shape of vibrations in the compression member, due to the fact that the bearing was running perfectly dry. This condition led to an investigation. As the river was frozen and there was no navigation at the time, the bridge could be left in the closed position while repairs were being made. After ineffectual attempts to drive out the pin by jacks and rams it was cut out piecemeal by an acetylene torch. The bearing was then adjusted, and a new pin and sleeve were placed. This repair work was done under the direction of the American Bridge Co.

Puddle Core Investigations at Tieton Dam, Washington

Goldbeck Cell Readings Show Consolidation—Sluicing Controlled by Corewall Movements—Direct-Pressure Observations—Ball-Penetration Tests—Friction Coefficients

By Ivan E. Houk
Engineer, U. S. Bureau of Reclamation, Denver, Colo.

DETAILED core investigations were made by the Bureau of Reclamation engineers during the construction of the Tieton hydraulic-fill dam on the Yakima project in south central Washington. Periodic readings were taken on Goldbeck pressure cells installed along the upstream face of the corewall, and on pressure gages directly connected to well points in the fill; depths of pool and core penetration were measured monthly with a 6-in., 30-lb. iron ball; samples of core material were taken and analyzed; horizontal displacement of the corewall was observed daily, to serve as a guide for the sluicing operations; and experimental determinations of friction coefficients were made for the sand and gravel deposited on the downstream side of the corewall. The more important results shown by the studies may be chiefly stated:

(1) The pressure observations showed that core was consolidating properly and that the section was stable at all times. The Goldbeck cell readings, while sometimes questionable individually, showed substantial agreement when considered collectively. They showed that the horizontal pressures at the lower cells were slightly greater than hydrostatic pressure during the first season of sluicing; that the pressure decreased when work was discontinued during two winters and increased when construction was active in the spring, the headings becoming quite discordant the second spring, probably indicating a more or less solidified core.

(2) Ball tests showed an average penetration below the pool water surface of about 9.7 ft., a depth somewhat less than was observed at the Miami Conservancy District's hydraulic-fill dams, probably due to the relatively higher percentages of very fine sand and silt and the relatively lower percentages of clay in the core material at Tieton.

(3) The mechanical analysis of the core samples showed that the average core material contained about 11 per cent of clay, 62 per cent of silt, 24 per cent of very fine sand, and 3 per cent of larger particles.

(4) Observations of corewall movements showed that the material placed on the downstream side of the corewall was sufficiently porous to drain readily, since observations following a suspension of sluicing generally showed a downstream movement. This downstream movement probably resulted from the decrease in pressure against the downstream side of the corewall as water drained out.

(5) Friction coefficients were found to average 0.51 for the sand deposited just below the corewall, and 0.60 for the coarse sand and gravel deposited 25 ft. below.

The Tieton dam, located on the Tieton River about 30 miles west of Yakima, is an earth, gravel, and rock-fill embankment 234 ft. high above the river bed. The vertical reinforced-concrete corewall is founded on bed rock 87 ft. below the river bed and extends to the top of the dam, 321 ft. above. Fig. 1 is a typical cross-section of the dam showing the general design. The material in the fill, both above and below the corewall, was hauled to the dam in cars, dumped on the outer slopes, and washed toward the center by hydraulic monitors, as shown in Fig. 2.

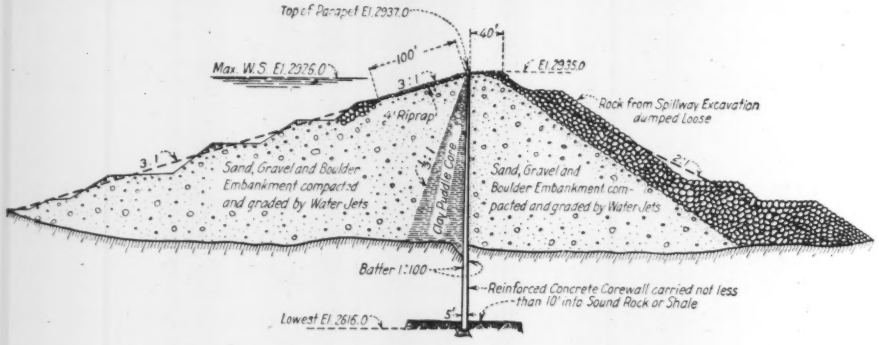

Top of Parapet El. 2937.0
40'
100'
Max. W.S. El. 2926.0
E. El. 2935.0
3:1
4' Riprap
Rock from Spillway Excavation dumped Loose
2:1
3:1
Sand, Gravel and Boulder Embankment compacted and graded by Water Jets
Sand, Gravel and Boulder Embankment compacted and graded by Water Jets
Batter 1:100
Reinforced Concrete Corewall carried not less than 10' into Sound Rock or Shale
Lowest El. 2816.0
5'

FIG. 1—TYPICAL CROSS-SECTION OF TIETON DAM

Installation of Testing Equipment—The testing equipment consisted of horizontal and vertical Goldbeck pressure cells, 1¼-in. by 18-in. well points with 60-mesh screens, for direct connection to pressure gages; and 3-in. galvanized flanged inspection pipes, for use in taking samples of material as well as to permit direct inspection of the core. The equipment was placed at different elevations on the upstream side of the corewall, opposite two inspection wells, built on the downstream side of the wall and 215 ft. apart. Fig. 3 shows the methods of installation and the elevations at which the different pieces of equipment were placed. The wells had an inside diameter of 4 ft. and were provided with manhole steps. For a description of the Goldbeck cell see *Engineering News-Record*, April 18, 1918, p. 758.

Seven Goldbeck cells were installed at each well. At the east well 3 cells were placed in a horizontal position, for measuring vertical pressures; and 4 were placed vertically, for measuring horizontal pressures. At the west well all cells were placed vertically. Vertical cells were placed in recesses in the wall, so that the faces of the cells were flush with the face of the wall. Horizontal cells were placed 2 ft. out from the wall on concrete shelves built integrally with the wall.

Well points were placed inside bags of fine gravel, so as to prevent plugging of the screens by clay or silt particles. Five points were installed at different eleva-

tions and locations, as indicated in Fig. 3. One point was placed in the sand and gravel just below the corewall (P_3), two points in the sand and gravel above the core (P_1 and P_5), and the remaining two (P_2 and P_4), in the fine material just above the corewall. Inspection pipes were installed with their open ends terminating at the upstream face of the corewall. The other ends were bolted to 3-in. gate valves set in recesses in the downstream side, where they could be reached from the inspection wells. The lowest pipe in the west well was fitted with a plate over the end of the valve, and a pressure gage attached. With the valve open this gage could be used to measure the pressure directly, as long as the fill against the corewall remained fluid.

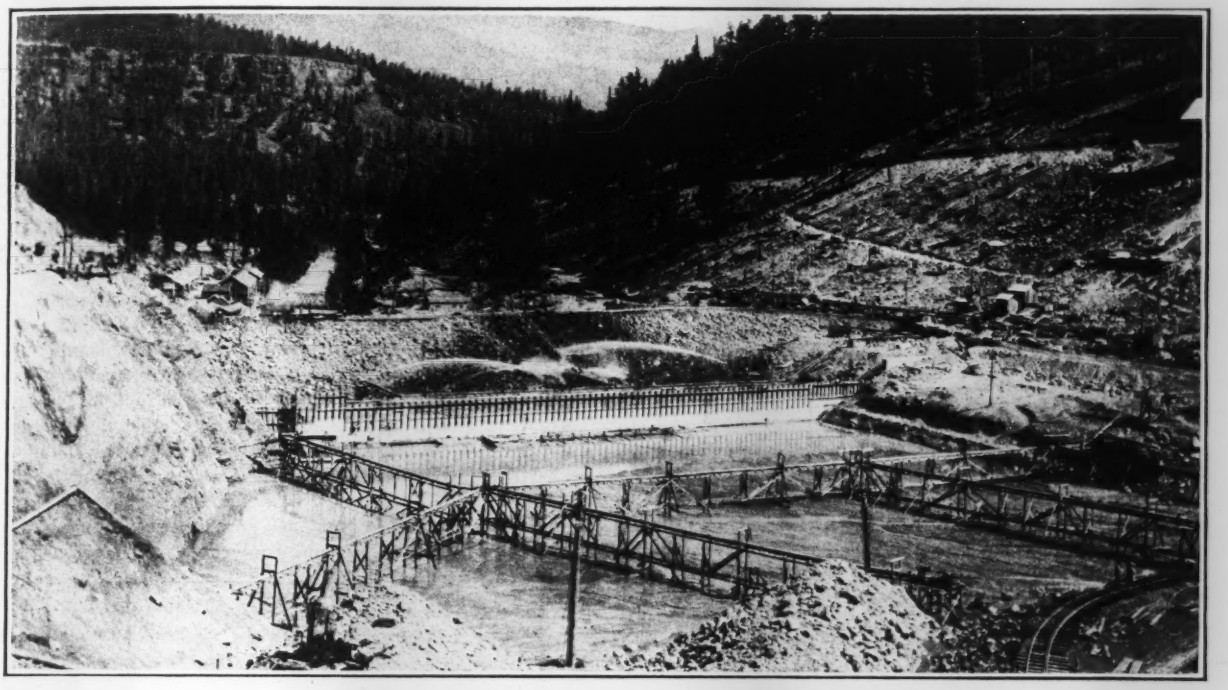


FIG. 2—BUILDING THE TIETON DAM BY THE SEMI-HYDRAULIC METHOD
Core pool in foreground on upstream side of corewall and gravel fill being washed into place below.

Goldbeck Cell Data—The experience at the Tieton dam in measuring core pressures with Goldbeck cells was essentially satisfactory. Some of the cells failed to register properly after a time and individual readings at others were sometimes questionable. However, the difficulties in securing accurate data and the discrepancies in the final results were no more pronounced than would be expected in any experimental work of such character. Readings at the two lowermost vertical cells H_1 and H_2, were quite consistent and checked very closely through two seasons of sluicing; readings at the higher vertical cells were also consistent and gave average curves nearly parallel to those determined by H_1 and H_2.

The results obtained at Tieton corroborated the experimental work carried out at the Miami Valley flood prevention dams near Dayton, Ohio. It is believed that the horizontal pressure data secured at Tieton were fully as satisfactory, possibly more so. Of course, the Bureau of Reclamation took advantage of the lessons learned on the Miami Valley flood prevention work, described by C. H. Paul, former chief engineer of the Miami Conservancy District, in *Transactions*, Am. Soc. C.E., 1922, p. 1181. It is believed that the installation of inspection wells at the Tieton dam, and the carrying of the connecting pipes directly through the corewall to the inspection wells, was a distinct improvement over the installation methods adopted at the Taylorsville dam. However, the installation of horizontal cells at Tieton, for measuring vertical pressures, was not as satisfactory as at Taylorsville. The cells were so close to the corewall that the readings became questionable as soon as the material began to solidify.

Horizontal pressure curves determined by readings at vertical cells H_1, H_2, H_3, and H_5, all located at the west wall, are shown in Fig. 4. Individual observations, represented by small circles, are shown only for cells H_1 and H_5, since to show all the readings would confuse the diagrams. For the same reason pressure curves for all the vertical cells are not given. Those shown are typical, and serve to indicate the consistency of the data. Dotted straight lines represent hydrostatic pressures at the elevations of the cells. The full straight lines, approximately tangent to the pressure curves at their origins represent equivalent fluid pressures for a unit weight of fill of 100 lb. per cu.ft. Vertical pressure readings taken on the horizontal cells when the depths of fill above varied from 20 to 40 ft., and while the readings still appeared to represent true pressures, indicated unit weights of approximately 110 lb. per cu.ft.

It will be noticed that the horizontal pressure curves in Fig. 4 are very similar. Those for cells H_1 and H_2, the two vertical cells at El. 2,747, are nearly identical during the first two seasons of sluicing; while the curves for cells H_4 and H_5 show the same general variations as those for cells H_1 and H_2. Curves for cells H_1 and H_3 show that the horizontal pressures at El. 2,747 increased at a rate slightly greater than hydrostatic during the first season of sluicing; that they decreased to a value somewhat less than hydrostatic

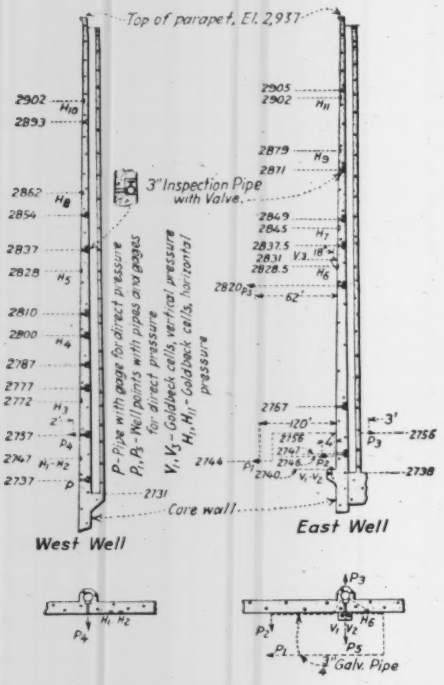

Top of parapet, El. 2,937
3" Inspection Pipe with Valve.
P-Pipe with gage for direct pressure
P1, P3-Well points with pipes and gages for direct pressure
V1, V3-Goldbeck cells, vertical pressure
H1, H2-Goldbeck cells, horizontal pressure
Core wall
West Well
East Well
3" Galv. Pipe

FIG. 3—INSPECTION WELLS AND LOCATION OF EXPERIMENTAL EQUIPMENT AT TIETON DAM

when work was discontinued for the winter; that they increased more or less uniformly along a line practically parallel to the hydrostatic line for a time after sluicing operations were resumed; that they then increased at a more rapid rate, reaching a value slightly greater than hydrostatic when work was again discontinued for the winter; that they remained at approximately the same value during the winter; and that they increased but little when sluicing was again resumed, the readings becoming quite erratic, probably indicating a more or less solidified condition of the core at El. 2,747.

The horizontal pressure curves in Fig. 4 show also that fluid pressures did not exist for any appreciable length of time after the cells were covered. The curves begin to deviate almost immediately from the 100-lb. equivalent fluid pressure lines. In no instance did individual observations indicate horizontal pressures as great as those represented by the equivalent fluid pressure lines, although vertical pressure observations for depths as shallow as 20 ft. indicated unit weights slightly greater than 100 lb. per cu.ft. for the material above. This checks Mr. Paul's statement (*Transactions*, Am. Soc. C.E., 1922, p. 1193) reading, "It is evident, from the data secured thus far, that properly graded core material need not be treated as a perfect fluid even after a few weeks of settlement, and that after it has been in place for a few months, the lateral pressure is only about 50 per cent or less, of the vertical pressure at the same depth."

Direct Pressure Measurements—Fig. 5 shows the water pressure in the Tieton fill as shown by readings on pressure gages directly connected to well points. No record is available for P_3. This point was placed in the sand and gravel below the corewall, where apparently the material was able to drain freely since no pressures could be measured. P_1, buried in the sand and gravel above the core, must have been surrounded by comparatively tight deposits, as it showed appreciable pressures. Readings at P_3, also buried in the sand above the core, responded more or less directly to changes in pool water surface elevation, thus indicating semi-porous material above. In this instance the pressure decreased definitely when sluicing was discontinued for the winter, and increased again when work was resumed.

Pressures at points P, P_1, P_2, and P_4 were less than hydrostatic in all cases. In fact they were nearly constant, regardless of height of dam, especially after the winter of 1922 and 1923 when the core pool remained at approximately El. 2,790. It seems reasonable that they should be independent of the pool surface elevation since they represent simply the pressures needed to force the water out of the core as consolidation progressed. The paths of least resistance along which the water traveled away from the well points probably did not change appreciably as the fill was raised.

Core Samples—Samples of core material were taken through the 3-in. inspection pipes on several occasions during the progress of the work. Since the inspection pipes were located at different elevations the sampling work furnished direct evidence of the consolidating of the core and supplied material for laboratory analysis.

Several core samples were submitted to the Department of Agriculture at Berkeley, California, for analysis. Table I gives the average results of the various tests arranged according to the grading adopted by the Bureau of Standards. The proportions of colloids present were not determined. Average analyses for the core materials used in the Henshaw dam of California and in the Miami Valley dams of southwestern Ohio, are also included. The combined percentages of clay and silt shown by the individual analyses of the Tieton core

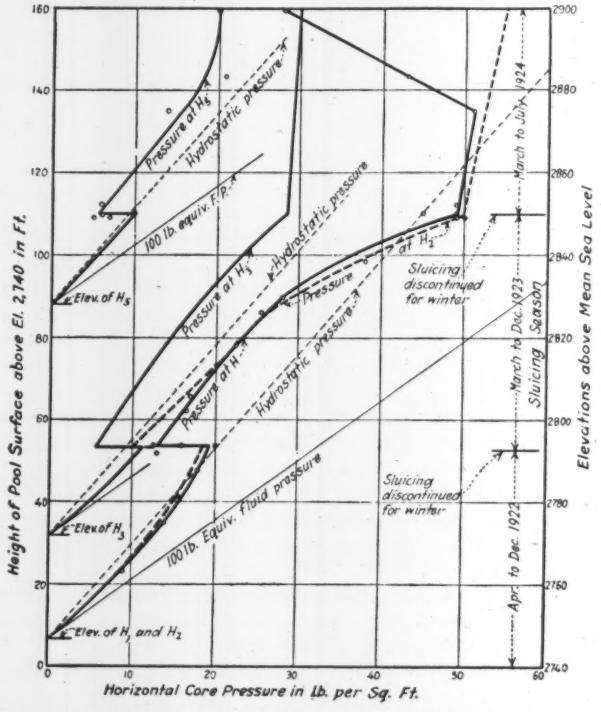

Height of Pool Surface above El. 2,740 in Ft.
Elevations above Mean Sea Level
Horizontal Core Pressure in Lb. per Sq. Ft.
Pressure at H6
Hydrostatic pressure
100 lb. equiv. F.P.
Elev. of H5
Pressure at H3
Hydrostatic pressure
Pressure at H4
Hydrostatic pressure
Elev. of H3
100 lb. Equiv. Fluid pressure
Elev. of H1 and H2
Sluicing discontinued for winter
Sluicing discontinued for winter
March to July, 1924
March to Dec. 1923
Sluicing Season
April to Dec. 1922

FIG. 4—HORIZONTAL PRESSURE BY GOLDBECK CELLS, IN CORE OF TIETON DAM

Note that in no case was the pressure as great as a 100-lb. equivalent fluid pressure, in most cases being less even than hydrostatic pressure. Note also sharp drop in pressure when work was discontinued during the first winter of sluicing.

varied from 29 to 93 per cent, averaging about 73 per cent. However, in only two instances were the combined percentages less than 69. Core analyses made at Tieton showed a specific gravity of approximately 2.65, an average weight of 76.8 lb. per cu.ft., dry and 110.9 lb. per cu.ft., wet, and average percentage of voids 54.5.

Ball Tests—Core consolidation was tested monthly by observing the penetration of a 6-in., 30-lb. iron ball.

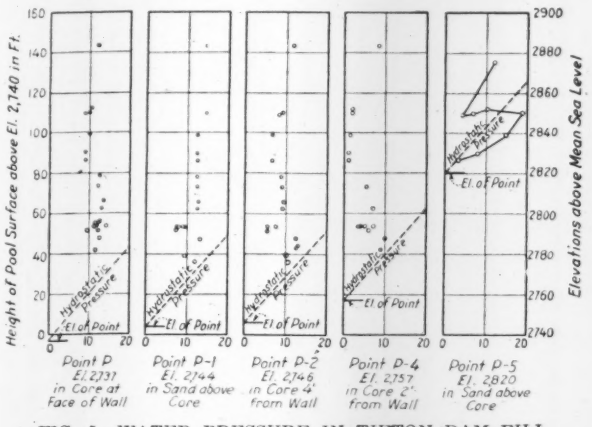


FIG. 5—WATER PRESSURE IN TIETON DAM FILL
Pressure gages used directly connected to well points.

The surface of the core was assumed to be the elevation at which the ball came to rest when swinging as a pendulum. The average penetration below the first point of rest was only 2.4 ft. However, after churning the ball up and down twelve times, through a vertical distance of 6 in., a further penetration of 1.8 ft. was observed. The total average penetration measured from the pool water surface was 9.7 ft., about the same as the Henshaw dam and less than at the Miami dams.

Sliding Coefficients—Sliding coefficients for the sand and gravel deposited below the corewall were determined experimentally, using a split box apparatus with an electrical control to indicate motion, arranged as shown

TABLE I—MECHANICAL ANALYSIS OF CORE MATERIALS AT TIETON, HENSHAW, AND MIAMI VALLEY DAMS

Material	Grading Dia. in Mm.	Tieton Dam. Per Cent	Henshaw* Dam. Per Cent	Miami Valley† Dams Per Cent
Fine gravel	2–1.0	0.1	1.5	0.0
Coarse sand	1–0.5	0.3	1.6	0.1
Medium sand	0.05–0.25	0.3	1.6	0.3
Fine sand	0.25–0.10	2.3	18.0	3.0
Very fine sand	0.10–0.05	24.1	58.6	18.2
Silt	0.05–0.005	62.2	12.9	55.9
Clay	0.005–0	10.7	5.8	22.2
Number of samples		12	...	22

Engineering News-Record, August 30, 1923, p. 342.
†*Transactions*, Am. Soc., C. E., Vol. LXXXV, 1922, p. 1187.

in Fig. 6. Table II gives the results of the experiments. The friction factor was found to average 0.51 for the sand just below the corewall, and 0.60 for the coarse sand and gravel 25 ft. below. The sand weighed 96.85 lb. per cu.ft. and contained 7.15 per cent of water by weight; the coarse sand and gravel, which would pass a 1½-in. screen, weighed 115.5 lb. per cu.ft. and contained 9.75 per cent of water by weight.

Corewall Movements—During the construction of the dam, daily and sometimes semi-daily measurements of corewall movements were made to serve as a guide for the sluicing operations. Owing to the difference in type between the upstream and downstream embankments a

TABLE II—DETERMINATIONS OF SLIDING COEFFICIENTS FOR SAND AND GRAVEL DEPOSITED BELOW COREWALL AT TIETON DAM

Material	Test	Top Load	Total Weight Moved	Pull Required to Cause Slip	Coefficient	Average Coefficient
			Lb.			
Sand just below corewall	A	90	494	255.5	0.51	
	B	144	548	281.5	0.51	0.51
Coarse sand and gravel 25 ft. below corewall	C	0	544.6	315.5	0.58	
	D	90	634.6	392.5	0.62	0.60

condition of unbalanced pressure could easily be established and continued to a consequent rupture of the comparatively thin wall. The measurements of the corewall movements made it possible to lay out the sluicing work so as to minimize the danger of trouble. Since it was practically impossible to keep the corewall rigidly in its original position it was decided to keep the movement as small as possble but always in a downstream direction. Also, before placing each 5-ft., 8-in. lift of concrete in the corewall, special precautions were taken to bring the center of the wall back to the true center line as established by monuments on the dam abutments, installed when the work was started.

Measurements of the corewall movements were made by first plumbing down from an offset line, 3.5 ft. from the true center line, determined by the monuments on the dam abutments, and then measuring the distance between the plumb line and brass plugs set in the bottoms of the inspection wells, or between the plumb lines and galvanized nails set in the side of the corewall.

From the time the brass plugs were installed in September, 1922, until Feb. 18, 1924, there was a total

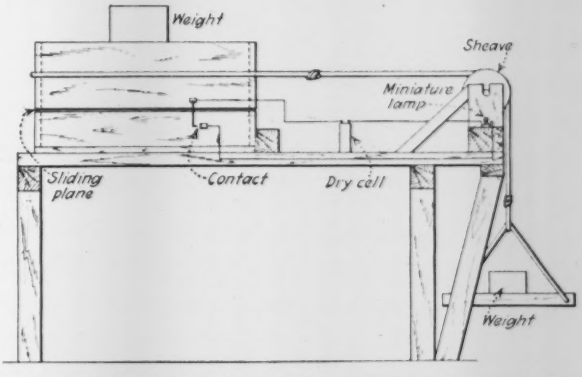


FIG. 6—TEST APPARATUS FOR DETERMINING FRICTION COEFFICIENTS OF GRAVEL FILL, TIETON DAM

movement downstream at the elevations of the plugs, 2,731 and 2,738, amounting to 0.061 ft., a little less than ¾ of an inch. During the sluicing season of 1922 the maximum movement of any point in one day was 0.03 ft.; and the greatest total movement of any point, during the time it could be measured was about 0.2 ft. The difference in pool surface elevations on the two sides of the corewall during 1922 varied from 2 to 6 ft. One of the interesting things noted in connection with the measurements of corewall movements was that when sluicing was discontinued at the end of the week there would be a downstream movement on Sunday, probably due to the draining of the downstream embankment.

W. C. Christopher, office engineer at Tieton during the construction of the dam, conducted the experimental work under the direction of J. L. Savage, designing engineer.

Experiments on Hydraulic Jump in Sewer Connections

Drop Connection, Rather than Free Fall, Drop Manhole or Flight Manhole; Eliminates Odor, Noise, Vibration and Energy

By Wells H. Ashley
Assistant Engineer, Sanitary District of Chicago

THE problem of connecting the city sewers of Chicago to the deep North Side intercepting sewer of The Sanitary District of Chicago, led to an interesting study of various means and the final adoption of a drop connection. The portion of the problem dealt with in this paper was that of getting the sewage from the city sewers to the comparatively low intercepting sewer under the requirements that it be odorless, noiseless, vibrationless and free from energy due to high velocity. The first three requirements were made necessary by the fact that in most cases the point of interception was in busy city streets. The fourth was due to the necessity of interfering with the flow in the intercepting sewer as little as possible.

A study was made of four methods of fulfilling these requirements: (1) Free fall into a pool. This method was considered to be odorous and noisy and to set up vibration although the energy was well dissipated in the fall. (2) Drop manhole with the sewage splashing from side to side upon plates projecting into the manholes. This method also failed in the first three requirements. (3) The flight manhole, with the sewage flowing down a series of steps. This method was considered to fail in all four requirements. (4) the drop connection, the sewage flowing smoothly down an incline approaching the free fall curve and having its energy taken out by the internal impact of the hydraulic jump and then flowing at low velocity into the intercepter. As this method promised to fulfill all four requirements if properly worked out it was given further study.

Few experiments on the hydraulic jump were on record but of these there were some of note that were helpful in our study. Of these perhaps the greatest aid came from the work at Miami described in Technical Reports (Part III) of the Miami Conservancy District and from an article "The Hydraulic Jump and Critical Depth in the Design of Hydraulic Structures" by Julian Hinds in *Engineering News-Record*, Nov. 25, 1920.

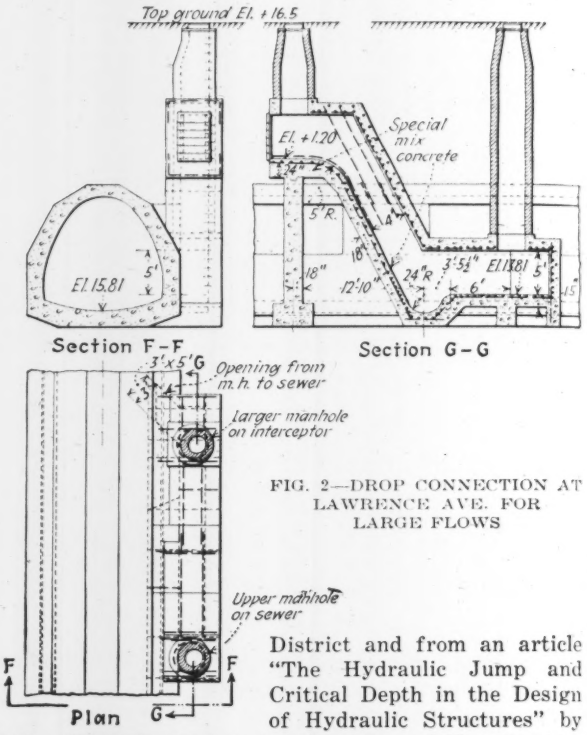


FIG. 2—DROP CONNECTION AT LAWRENCE AVE. FOR LARGE FLOWS

A study of previous experiments indicated (1) that in most cases the depth of tailwater was constant, which would not be the case where it depended upon the depth of flow in an intercepting sewer and (2) that there was usually room for a long run before the jump, whereas it was necessary to confine it in this case to decrease the cost of the structure. Also knowledge was lacking concerning noise, vibration, carrying capacity after the jump, character of stream down a confined chute, the effect of changing the section of the stream at the upper end of the chute, wear due to high velocities, etc. For these reasons it was considered necessary to build a model and perform some experiments, con-

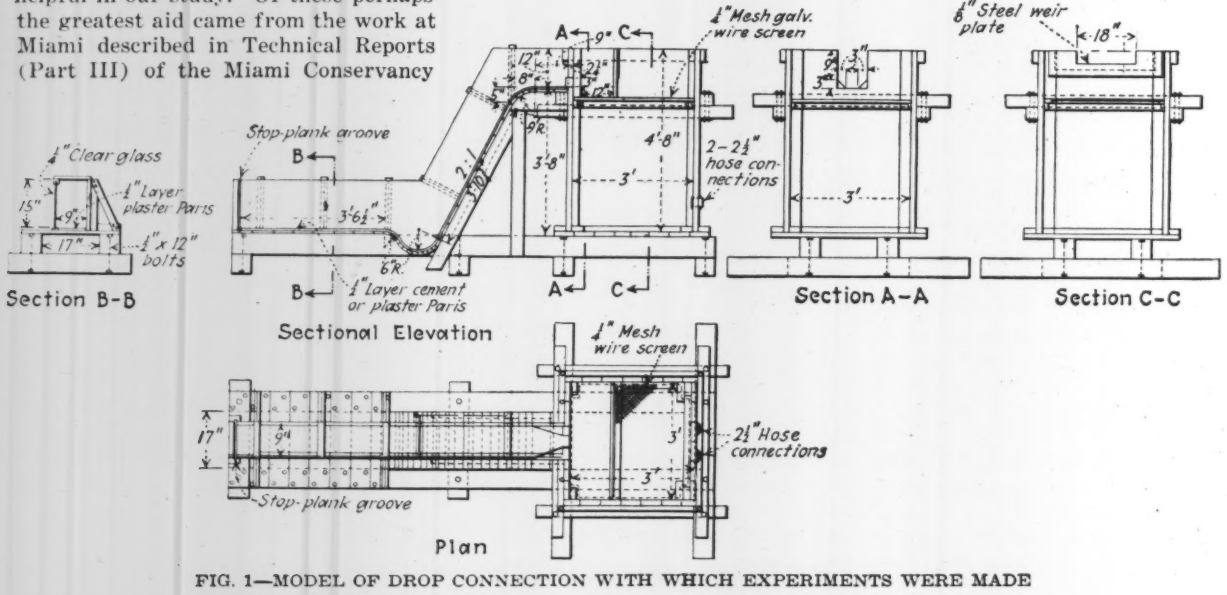
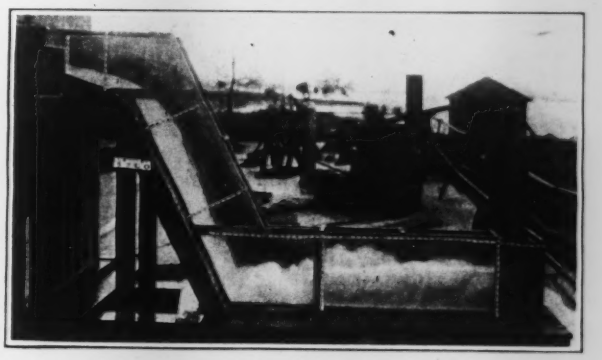
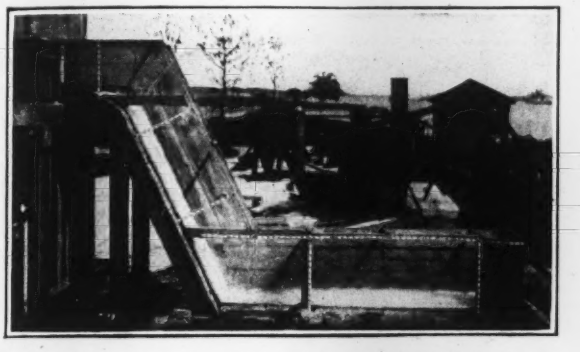


FIG. 1—MODEL OF DROP CONNECTION WITH WHICH EXPERIMENTS WERE MADE

(32TO) Medium quantity flowing (Q = 0.48 sec.-ft.). Medium tailwater (D_2 = 6.45 in.) After the jump the disturbance is mainly on the surface of the water and the bottom velocity is broken up as indicated by the rock deposited just downstream.



(43LW) Medium quantity flowing (Q = 0.518 sec.-ft.). Medium tailwater (D_2 = 9.25 in.). The water is not turbulent downstream from the jump but the bottom velocities are not broken up as indicated by the distance rock was carried downstream showing necessity of hopper.



(10TO) Small quantity flowing (Q = 0.084 sec.-ft.). Low tailwater (D_2 = 1.10 in.). The flow down the incline is smooth, the jump takes place in the hopper, showing the value of the hopper for low flows.

(73LO) Large quantity flowing (Q = 0.710 sec.-ft. and D_2 = 9.15 in.) with high tailwater, showing clearly that the hopper helps to localize the jump, the turbulence being mainly on the water surface.

FIG. 4—MODEL, WITH GLASS SIDE, IN OPERATION

forming as nearly as possible to the conditions that would arise in the interception of sewage.

A study design had been made for one drop connection which was to take a maximum quantity of about 32 sec.-ft. The sewage was to enter a chamber at the top of the drop connection with a trapezoidal section, then taper out to a rectangular section 3 ft. wide at the top of the chute and go down over an arc of 3-ft. radius and a 2 on 1 incline tangent to it. At the bottom a hopper had been designed on a 2-ft. radius reverse curve with the idea of localizing the jump, after which the channel was carried along level for a short distance and through the side of the intercepting sewer at 45 deg., the chamber having a square end even with the farther side of the opening. It was decided to use this design reduced to one-quarter scale for the model.

The model was built of timber with a calked timber tank on one end into which two fire hose discharge near the bottom forcing the water to rise (with the tank acting as a stilling basin) and pass through ¼-in. mesh wire netting to break up any currents. The bottom of the flow channel was covered with ½-in. mesh wire netting and plaster of paris applied to form a smooth surface. One side of the flow chamber was made of glass so that photographs could be taken as the experiments were performed. Cloth tape was fastened to the outside to give the correct scale in the photographs. Exposures of about one-tenth second were used in making the photographs to allow the bubbles to move enough to indicate the thread of the stream. As the effectiveness of the hopper at the bottom of the chute was unknown, a wooden plug was provided that could be fitted into the hopper so that tests could be made with flow going straight out from the bottom of the incline.

In carrying out the experiments the flow was regulated by turning on the valves connected to the fire hose. Then as soon as a stable flow was attained the depth of tailwater was varied by the use of the stoplogs in

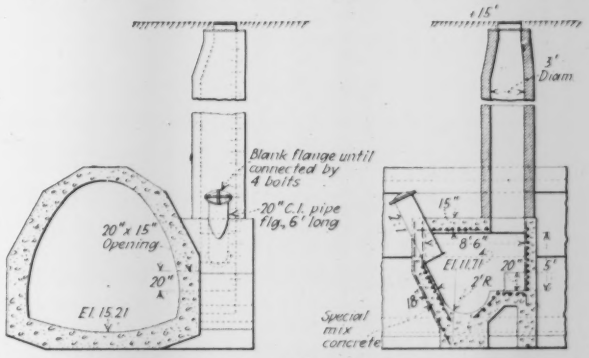


FIG. 3—DROP CONNECTION AT WILSON AVE. FOR FLOWS UNDER 10 SEC.-FT.

the lower end of the flow channel, the usual procedure being to vary the tailwater depth until the stream jumped free in case the hopper was in use, take a photograph, put in another stoplog or two until a jump was secured and take another photograph. Measurement of the quantity of water was made by recording the depth of flow over the weir. This was found by placing a needle in the end of an ordinary engineer's scale and

scaling down to the water surface, datum being found by allowing the water to come just even with the crest of the weir. A depth measurement 2 ft. from the lower end of the flow channel was used to compute average velocity.

Comparison was made of the effect of using a hopper at the bottom of the chute and of having the hopper filled and the invert of the lower channel joined with the incline with a smooth curve. Slow exposures allowed bubbles to traverse on the photographic plate in these tests. Thirty-five separate runs were made and photographed, 13 with the plug out of the hopper and the taper blocks in, 17 with the plug in and blocks out and 5 with both plug and blocks out. The quantities varied from 0.084 to 0.742 sec.-ft.

Compared with similar experimental work in German hydraulic laboratories, as given by John R. Freeman after this work was done, the German work is precise and scientific while this is acknowledged to be rough to guide design only. The Germans used black sawdust.

From the model tests it was concluded: (1) The weir was too close to the top of the chute, and not all the air imprisoned by the water going over the weir was released before it got to the chute. This and the trough shape of the flow made the water surface too rough to permit measurement of the depth of flow. (2) The effect of the taper blocks at the upper end of the chute was negligible. (3) The radius of the curve at the top of the chute was not large enough, the water tending to leap away from the incline. (4) The jump could be localized very near the bottom of the chute if sufficient tailwater was provided. (5) The disturbance caused by the jump was noticeable for a distance of from 2 to 4 ft. after the jump but, except in the case of large quantities and low tailwater, the effect was mainly upon the surface of the water. (6) The hopper had the effect of furnishing extra tailwater depth for low flows, aided in breaking up bottom velocity and helped to localize the jump for larger flows. (7) The velocity after the jump was sufficient to carry away light material and grit but coarse objects were deposited just below the hopper. (8) For low flows when the effect of the weir was not so unfavorable and the flow followed the chute in a smooth stream there was practically no noise. (9) Even for large flows there was little vibration. (10) High velocities down the chute finally wore the plaster of paris down to the wire netting.

The design was then made with these observations in mind. A transition was made in the sewer before joining the drop connection at the upper manhole. The radius of the curve at the upper end of the chute was increased from 3 to 5 ft. The invert at the lower end was set at such an elevation as to secure sufficient tailwater for the worst case. A uniform distance of 6 ft. from end of reverse curve at bottom to nearest edge of opening leading to the intercepter was adopted, a special mix of concrete was specified for the bottom slab and the reinforcing steel was required to be covered by 6 in. of concrete on the incline and in the hopper.

In the application of this design the width of the drop connection was proportioned to the maximum quantity to be intercepted, the rule adopted being 1 ft. in width for every 10 sec.-ft. of sewage extreme maximum flow with a minimum width of 3 ft. For quantities under 10 sec.-ft. a cast-iron pipe was used in place of the chute, with the lower chamber 3 ft. wide and shaped to decrease the size of the structure. Several drop connections have been built for operation upon the completion of the North Side sewage-works in 1928.

The development of the above design was made by the writer under the direction of O. L. Eltinge, engineer of sewer design, and assistance in running the tests was rendered by W. A. Reinert, assistant engineer, both of the Sanitary District of Chicago, of which E. J. Kelly is chief engineer.

HYDRAULIC JUMP TESTS WITH MODEL OF SEWER DROP CONNECTION

Index*	Q Sec.Ft.	Depth of Tailwater, In	Remarks
10TO	0.084	1.10	(With hopper) Small Q, low D, smooth flow down incline, jump takes place in hopper and flows away quietly
32LW	0.138	4.95	(Without hopper) Small Q, medium D, smooth flow and quiet jump.
14TO	0.083	8.45	(With hopper) Small Q, high D, smooth flow, slight turbulence in jump.
36LW	0.140	12.75	(Without hopper) Small Q, maximum D, smooth flow, slight turbulence.
20TO	0.220	.....	(With hopper) Small Q, insufficient depth of tailwater, flow jumps free upon leaving hopper.
31LW	0.138	2.55	(Without hopper) Small Q, insufficient depth of tailwater, flow rushes away from bottom of incline for some distance before jumping.
22TO	0.218	5.60	(With hopper) about same Q as in 20TO with medium tailwater. The energy of the flow down the incline is well dissipated, the discharge being smooth and at low velocity. A rock was thrown out of hopper.
12LW	0.310	6.25	(Without hopper) Small Q, medium D, good jump, smooth discharge.
24TO	0.217	9.40	(With hopper) Small Q, high D, jump localized to vicinity of hopper.
15LW	0.308	.25	(Without hopper) Small Q, (40% greater than 24TO) high D, turbulence of jump extends for two-thirds the length of model.
30TO	0.347	.....	(With hopper) Medium Q insufficient tailwater flow jumps free.
10LW	0.325	0.85	(Without hopper) Medium Q, insufficient D, high discharge velocity.
32TO	0.348	6.45	(Without hopper) About same Q as 30TO with just enough tailwater to produce jump. After jump disturbance is mainly on surface of water. Bottom velocity broken up and rock deposited.
23LW	0.382	7.95	(Without hopper) Slightly greater Q than in 32TO. Bottom velocity not broken up as quickly as indicated by distance rock was carried.
35TO	0.347	12.45	(With hopper) Medium Q, excessive D, jump fairly well localized.
25LW	0.360	11.95	(Without hopper) Medium Q, high D. Turbulence extensive.
44LO	0.396	8.75	(With hopper) Medium Q, medium D, just enough tailwater to produce jump. Fairly smooth flow at discharge
13LW	0.307	7.95	(Without hopper) Small Q, medium D, local jump and smooth discharge.
51LO	0.516	.....	(With hopper) Medium Q, insufficient tailwater, flow jumps free. Water climbing sides of incline due partly to too small radius of curve at top.
41LW	0.518	.....	(Without hopper) About the same Q as in 51LO, insufficient tailwater to produce jump. Water thrown out above stoplogs beyond end of model.
53LO	0.575	8.20	(With hopper) Medium Q, medium D, just enough tail water to produce jump. Turbulence mainly on the water surface
43LW	0.518	9.25	(Without hopper) Medium Q and D, good jump and smooth discharge.
70LO	0.697	.....	(With hopper) large Q, insufficient tailwater, flow jumps free.
72LO	0.697	7.05	(With hopper) Large Q, medium D, just enough tailwater to produce jump. Turbulence extends through length of model.
62LW	0.742	.....	(Without hopper) Large Q, insufficient tailwater to produce jump within limits of model.
63LW	0.742	10.05	(Without hopper) large Q, medium D, jump not localized, turbulence extends through model.
73LO	0.710	9.15	(With hopper) large Q, showing the effect of varying the depth of tailwater. 74LO shows clearly that with the hopper the jump is localized and the turbulence is mainly on the surface of the water.
74LO	0.712	10.85	
75LO	0.715	12.50	
65LW	0.742	13.75	(Without hopper) Large Q, maximum D, smooth jump and discharge.
53LW	0.726	9.95	(Without hopper) Large Q, medium D, disturbance carried through model with fairly smooth discharge.
22LW	0.382	4.75	(Without hopper) Medium Q, insufficient D to produce jump within limits of model.

**Explanation of Index Notation*—The first figure refers to the number of the run. The second figure refers to the number of stoplogs used. The third figure or rather letter signifies whether the stoplogs were placed tight "*T*" or loose "*L*." The last figure or letter denotes whether the wooden plug was in the hopper "*W*" or out "*O*." Thus 32TO is interpreted as follows: Run 3, with two stoplogs placed tightly and with the plug out of the hopper.

Abrasive Wear of Hard Pavements Proved in Columbus

Brick Pavement on Heavy-Traffic Street Shows Rutting Where Vehicles Track and Even Wear Where Traffic Spreads

By R. H. Simpson
City Engineer, Columbus, Ohio

DOES modern traffic wear the surface of so-called hard-surface pavements? Is abrasion or wear an important factor to be considered in the design of heavy-duty pavements? These questions are being asked by many engineers, today, and there seems to be a difference of opinion as to the correct answer. In a test of a concrete pavement, a few years ago, the Bureau of Public Roads came to the conclusion "that rubber-tired traffic alone does not appreciably abrade the surface of a concrete pavement," and many highway and municipal engineers feel that, since traffic today consists almost exclusively of rubber-tired vehicles, the wear of a pavement surface is negligible and may be disregarded. On the other hand, there are many who feel that such a conclusion is not justified by the facts. In connection with some studies of maintenance costs and traffic volume, the writer has had the opportunity to observe the wear on a hard surface pavement that has been subjected to heavy traffic for a period of eleven years. The result of this study is presented herein with the thought that it would throw some light on this question and be of interest to all those engaged in the construction and maintenance of pavements.

This pavement was constructed on a thoroughfare in Columbus, Ohio, which leads from the central business district to an outlying section of the city. The roadway is 46 ft. in width between curbs, with a double-track street railway in the center. The pavement consists of brick laid on a concrete base and was constructed in 1915. The brick were laid on a sand cushion, the joints being filled with asphalt. They were 8½ in. long, 3½ in. wide, 4 in. deep, and were made of No. 2 fireclay with about 15 per cent of shale. The average of the results obtained from the standard rattler test showed a loss in weight of 17.43 per cent. All the tests showed, as well as our experience with these brick, that they are a very satisfactory paving brick.

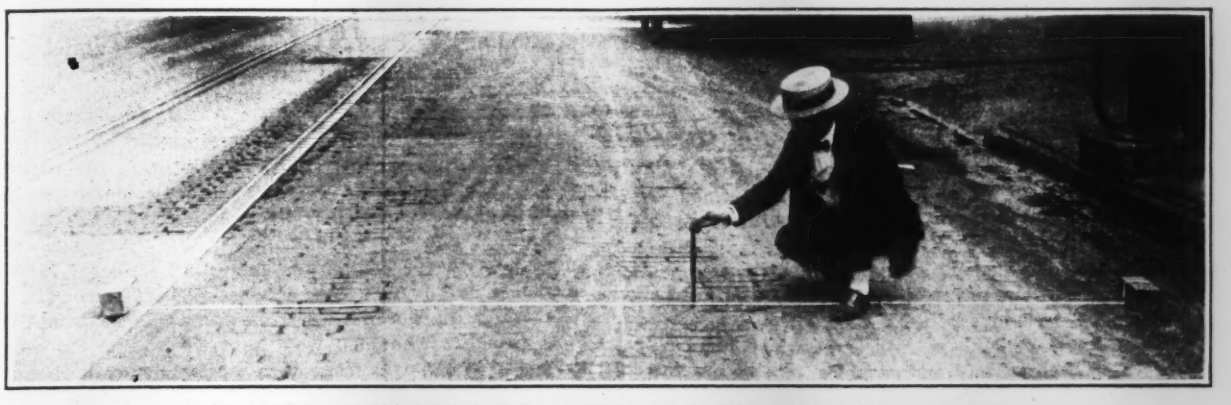


FIG. 1—RUTTED PAVEMENT WHERE STREET CARS CROWD TRAFFIC INTO ONE TRACK

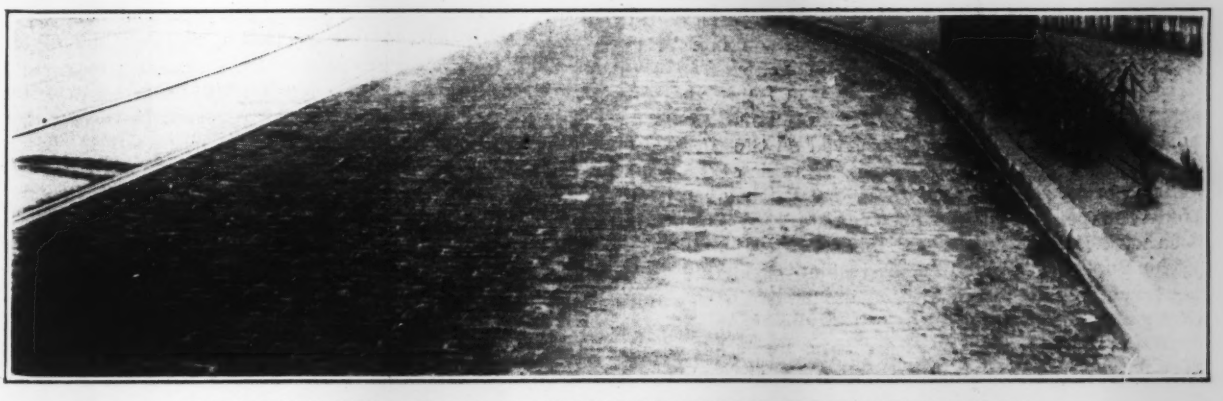


FIG. 2—EVEN WEAR AND NO REPAIRS ON PAVEMENT WHERE TRAFFIC SPREADS

A traffic census taken in 1925 showed that the number of vehicles using this street daily was 17,350. Of this number about 16 per cent were commercial cars, one-fourth of these or 4 per cent of the total being heavy trucks. About two-thirds of 1 per cent were horse-drawn vehicles, and the balance passenger cars. The number of vehicles registered in the city during this year was 64,237. This means that 27 per cent of the registered vehicles used this street daily. A count during the year 1926 shows a larger volume of traffic but approximately the same percentage of registered vehicles. Now, if we assume that this same percentage of registered vehicles has used this street daily in past years, the conclusion is reached, by applying this percentage to each year's registration, that there has been an average daily traffic of 9,300 vehicles over this pave-

ment during the ten-year period. On the basis of a 300-day year this would amount to a gross traffic of 27,900,000 vehicles, half in each direction.

The width of the pavement is such that there is just room for a moving vehicle to pass between a street car and a vehicle parked at the curb. Therefore the traffic for a considerable portion of the length of the street is confined to a strip of pavement about 8 ft. in width. On one section where there is only occasional parking of cars, the traffic spreads out over most of the width of the pavement from rail to curb. On that section where the traffic is confined to a narrow lane the pavement has been worn into two well-defined ruts on each side of the car tracks. On the other section there has been no rutting, the brick being worn uniformly, excepting a narrow strip along the curb.

In 1925 repairs were made to that section of the pavement that was badly rutted and it was found that the brick in these ruts were reduced to a depth of 2.6 in., indicating a wear of 1.4 in. from the ten-year traffic. If we assume that all of the traffic in one direction, that is 13,950,000 vehicles, has passed over this section, we reach the interesting conclusion that the wear produced by one million vehicles is 0.1 in.

On the section where traffic is not confined to a narrow path, no repairs to the pavement have been required, and the surface is in excellent condition after eleven years' service. In order, however, to determine the thickness of the pavement on this section, a number of brick were removed in 1925, and they were found to have a depth of 3.58 in., indicating a wear of 0.42 in. With the same assumptions as above, we may conclude that the wear on this section per million vehicles amounts to 0.03 in. One year later more brick were removed from this section of the pavement in order to determine whether or not the wear from one year's traffic, amounting to about 2,650,000 vehicles in each direction, would be noticeable. It was found that the wear on these brick averaged 0.49 in. This is 0.07 in. more than the average wear observed on those removed one year previous. In other words a traffic of 2,650,000 vehicles produced a wear of 0.07 in., which amounts to 0.0264 in. per million vehicles, and agrees reasonably close with the figure obtained above.

The Bureau of Public Roads test of a concrete pavement referred to above and as described in the May, 1924, issue of *Public Roads* gives the wear on each section of the pavement. In this test the wheels were confined to a narrow path, and the wear resulting therefrom may be compared with the results obtained from the concentrated traffic on the brick described herein, except that the latter has had a small amount of steel-tired traffic as well as some traffic with rubber tires equipped with chains. The average wear on the concrete pavement from 55,000 trips of the specially constructed vehicle was 0.0097 in. At the same rate one million trips would have resulted in a wear of 0.175 in.

It will be noted that where traffic has been confined to a narrow lane, the wear was 3½ times as much per million vehicles as on the section where it could spread out over a greater width. If this ratio be applied to the results of the Bureau of Public Roads test, the wear per million vehicles, for non-concentrated traffic, on the concrete pavement, would be 0.052 in. as compared with 0.03 in. for brick. From the data presented herein, may we not conclude:

(1) That modern traffic will abrade the surface of hard-surface pavements.

(2) That, where traffic is confined to narrow lanes the abrasion will be at least three times as much as where it is not concentrated.

(3) That for pavements carrying a light traffic, not exceeding 2,000 vehicles daily, the abrasion will not be of such an amount as to be of great importance for a 20-year period.

(4) That in the design of pavements expected to carry a traffic in excess of 10,000 vehicles daily, abrasion is a very important factor to be considered.

Kansas City Water Tunnel Blast Caused by Natural Gas

Committee Finds that Men Entered Tunnel Too Soon—Suggests Changes in Contractor's Methods

THE COMMITTEE of engineers, named by the city manager of Kansas City to investigate the recent explosion in the water tunnel now under construction in which eight men lost their lives, submitted a report of its findings and suggestions on Sept. 23. The explosive substance was described as "shale gas" and the igniting spark is believed to have come either from closing a switch to start a motor-driven pump or else from the motor itself. The men went into the tunnel too soon after the ventilating fans were started, but there was no evidence that they were ordered to do so by any one in authority over the shift foreman who was one of those killed in the explosion. No blame is fixed upon either the contractor or engineers although the report concludes with suggestions to the contractor on certain changes in his construction procedure designed to better cope with the gas hazard. As reported in these pages last week by Fuller & Maitland, the engineers in charge of the work, dynamite apparently played no part in the explosion.

The tunnel is a 7½-ft. bore with an ultimate length of 15,500 ft. and is being constructed to bring the water from the new filtration plant in North Kansas City to the distribution reservoirs on the south side of the Missouri River. It is some 275 ft. below the ground surface in limestone and shale. The blast occurred shortly after 5 a.m. Sept. 15, following a 4-hr. shutdown of the ventilating system because of the breaking of a belt on the blower fan.

The report of the committee was based on testimony of witnesses and also on a personal inspection of the tunnel itself. The following information is abstracted from the report of the committee:

The ventilating system went out of order about 12:30 a.m. Sept. 15, and the men were immediately ordered from the tunnel. It was placed back in operation at approximately 4:30 a.m. following which the men went down into the shaft. After a walk of about ½ mile from the bottom of the shaft to the tunnel heading, it is estimated they were making ready to go to work when the explosion came, at approximately 5:05 a.m.

The committee's trip into the tunnel was made Friday morning. Between the floor of the cage and the lining of the shaft there is ample room for all necessary air to enter the tunnel. Approximately 2,000 ft. of the tunnel is lined with concrete. In the first 1,400 ft. practically no debris was encountered, except that the blower pipe in several places had been injured by the explosion. At 1,400 ft. a

"firing room," providing safety for the men during blasting, had been excavated outside of the main tunnel bore. This room was fairly well intact, although some timber protection was displaced. Going on from here, there were encountered at very frequent intervals broken ventilating pipe, massed and entangled concrete forms, track rails and timbers. This condition was prevalent until we reached the end of the concrete, at a point approximately 2,000 ft. from the shaft. At the mouth of the concrete were two heavy mucking machines which had been moved by the explosion a distance of approximately 25 ft. and upset, jammed together and stopped in their movement by striking against the concrete of the tunnel itself.

From the end of the concrete, for a distance of approximately 275 ft., no timber was necessary to hold the roof up. At 275 ft., the timbered tunnel started. At approximately 350 ft. from the end of the concrete is the point where the body of the motorman was found and the portion of the tunnel that seemed to be the center of the explosion. This was very close to the point where an electric-driven water pump had been installed. The switch controlling the operation of this pump was found closed. Fifty feet further on was found a train of cars, approximately 80 ft. long. In one of these cars was a case of dynamite, unopened. The end of the train was approximately 40 ft. from the face of the tunnel and there was one lone car between the end of the train and the bottom of the muck pile. The muck pile extended for about 25 ft. to the face of the tunnel. Two bodies were found on this muck pile.

We found that the ventilating pipe extended to within 12 ft. of the face of the tunnel. The ill-fated shift had done a major part of the drilling for another shot before the ventilating system broke down, but none of the holes had been loaded with dynamite. Our investigation of the tunnel leads us to believe that the blast was caused by the explosion of shale gas, and that the center of the explosion was at the point where the electric-driven pump was installed.

From testimony and our investigation of the plant, we believe that the capacity of the ventilating machinery is adequate for the tunnel, as far as it has gone and as long as gas does not enter the tunnel in a greater volume than at the present time. All the testimony leads us to believe that the men entered this tunnel before a reasonable time had elapsed for clearing the gases. A reasonable minimum of time for entering the tunnel after such a 4-hr. shutdown is, in our opinion, not less than 50 min. As all foremen of the shifts were supplied with safety lamps and the evidence shows that this crew had one, it is hard to account for the fact that this shift entered the tunnel and passed to the heading without discovering gas. As the clearing of gases in the tunnel does not take place by the fresh air acting as a plunger and forcing gases ahead of it, but by a gradual replacing of the gases in an inward and upward movement, there would be a period when fresh air was at the bottom and gases at the top of the bore. It may be that the lamp was carried through the tunnel at an elevation below the gases, with the result that the lamp did not indicate the presence of gas. The man carrying the lamp should have tested for gas at the top of the tunnel at regular intervals as he advanced.

We believe that the most probable cause of igniting the explosion was a spark caused either from closing the switch at the water pump, or from a spark from the motor driving the pump. With the thought of preventing the recurrence of such an accident, we believe that the city has a full right under the clause of the contract requiring proper ventilation to insist upon the company's complying in the main to the following suggestions:

(1) That a duplicate blower and motor be installed in the power plant to be used in case of any breakdown of motor or fan.

(2) That in case of any breakdown of the ventilating system in the future, the superintendent in charge of the work be required to investigate air conditions for the full length of the tunnel before permitting the men to resume work.

(3) We believe that better ventilation would be accomplished if the concreting of the tunnel be kept closer to the face when passing through a shale that is known to bear injurious gases. However, we realize in making this recommendation that we are prescribing a method of procedure with the work that may, to some extent, hinder progress and may be an infringement on the contractor's rights to use his own construction methods.

(4) If it is found that the concrete cannot be kept within a distance of 350 ft. from the heading without retarding progress, the contractor should install any and all necessary additional ventilating equipment to insure the circulation of fresh air, not only in the concrete-lined tunnel, but also into the unlined portion and against the roof of the excavation between the concrete and the heading.

(5) That as nearly as practicable all the spark-producing machinery be kept in the concrete portion of the tunnel.

(6) That all men working in the tunnel should be instructed as to the use of the safety lamp, as to the length of time that should elapse between a break-down and the time when they could be reasonably safe in entering the tunnel, and that the men be not allowed to enter the tunnel until the superintendent has made the test above prescribed.

The committee making the investigation consisted of M. S. Murray, director of public works, chairman, and N. T. Veatch, Jr., and Col. E. M. Stayton, engineers on the city's new sewerage system.

Railway Electrification Law Enjoined

IN VIEW of the widespread interest in railway electrification some abstracts from the decision of the District Court, Southern District, N. Y., in enjoining the operation of section 53-a of the New York State Railroad Law, are worth quoting. The full text of the decision was not available when our news note of Sept. 16, p. 479, was written.

The court said, in part, after commenting on the fact that in so far as the Fourteenth Amendment was concerned the section of the New York State law was valid:

Nevertheless, with all these things conceded, the question still remains whether the section conflicts with any lawful action of Congress already taken, and is unconstitutional in that sense. If it does, the federal power prevails.

The original Boiler Inspection Act of 1911, as its name implies, did not cover all parts of the locomotive and was necessarily limited to steam. In 1915 it was, however, extended to cover the locomotive, its tender and their appurtenances.

On July 7, 1924, more than a year after section 53-a of the Railroad Law of New York was passed, this act as amended was extended to all locomotives, electric as well as steam, and the system became complete. It is with this statute in view that we must determine the validity of the local law.

Had section 53-a contented itself with merely directing all railroads to use electricity, an argument might be made that it did not impinge upon the powers so conferred by Congress. It might be said that the kind of locomotives to be used was left for the determination of the commission and that all that was required was that they should use electric power; that the decision as to where steam and where electricity was to be employed had not been confided to the commission but remained within the powers of the states as they might find it necessary for local purposes to prescribe.

We may avoid it because section 53-a is not confined merely to requiring the railroads to substitute electricity for steam. It goes further and assumes to give the power to prescribe not only the structures external to the locomotive, i.e., the poles, wires, safety devices, conduits, etc., but the "appurtenances and equipment" to be used.

Nor can we say that section 53-a is valid in so far as it requires the substitution of electricity, and void in so far as it gives power to the local commission to determine the kind of locomotive with its appurtenant poles and wires or third rail. To do so we must assume that the state would be content with whatever the federal commission might prescribe, a conclusion certainly at variance with what it has said. Until we can be assured that merely to avoid steam was so paramount a purpose that the state would entertain it regardless of how it might be fulfilled, we have no right to divide the statute and say that it is valid in part and void as to the rest.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Hurricane Destruction in Southern Florida

East Coast Devastated by Unprecedented Storm—Two Miami Skyscrapers Shattered—Moorehaven Flooded

By Wire from F. E. Schmitt
Associate Editor, Engineering News-Record

Miami, Fla., Sept. 27, 1926.—Southern Florida's hurricane of Sept. 18 wrought damage of unprecedented severity and extent. Sweeping a 70-mile strip of the famous East Coast it destroyed houses and other human works in countless numbers. Deaths may total five or six hundred and property losses are tremendous though no dependable figures are available. But aside from these effects and widespread disorganization of community life the hurricane is marked by facts and happenings of special engineering significance. These include the unexampled violence of the storm, the accompanying deluge of rain and the high storm tides, the shattering of two modern skyscrapers in Miami—a startling structural experience — and the overwhelming of a town by storm-driven lake waters.

Storm Belt Wide

Storm destruction is distributed over a belt 60 to 70 miles wide nearly centered on Miami embracing the southern part of the East Coast from Pompano south to Florida City; thence northwesterly the path crossed the Everglades and the southern part of Lake Okeechobee, where Moorehaven and vicinity was involved. West of the latter point, violence of the storm was much less.

The hurricane exceeded all prior ones in the United States in the opinion of R. W. Gray, weather observer at Miami. A record low barometer of 27.6 was reached. The wind velocity is rated at 125 miles per hour. Throughout the storm a deluge of rain fell with a 16-hour total between 8 and 15 in. Rain and spray were driven horizontally, obscuring vision and undoubtedly adding large impact action to the wind pressure.

Structural Damage Divergent

Damage to structures in the East Coast region is of wide variety. In Ft. Lauderdale, Dania, Hollywood, Hialeah, Miami and other towns houses were unroofed, overturned, crushed or otherwise wrecked. Sky signs, Spanish tile roofs, parapets, projections of all kinds, loose roofs, suffered early and very generally. Some loose I-beams were blown from an upper story of a high building under construction in Miami. Missiles of all kinds added to the wind action in producing destruction. A steel and a brick stack of the Florida Power and Light Co. electric station at Miami were broken off but the company's group of gasholders weathered the storm. A set of high radio towers at Hialeah was blown over. Elevated water tanks on towers generally survived. In many buildings entire wall panels of tile or concrete blocks were blown in, some by failure of bond with the frame, some by crushing. On the ocean front, the water rose 7 ft. and on the west shore of Biscayne Bay it went over the sea wall and deposited many large boats on and beyond the bay drive. Much washing and caving occurred along the beach, damaging roads and buildings to large amounts.

Poor Building Suffers

Gathering together the mass of detail fact from which better building against hurricanes may be learned will require many weeks of organized work which it is hoped Florida engineers will undertake. This will include deducing actual pressure and impact forces, which are subject to special doubt because of the wide diversity of destructive effects manifested. But two general observations already certain are first, that good house carpentry made a most creditable showing in the whole storm area, and second, that well designed and well-built engineering structures though designed for no more than the customary 20 to 25 lb. per sq.ft. can live through a hurricane even as violent as this one. One proof of this lies in the integrity of all but two of Miami's large business buildings, whether steel frame or reinforced concrete. As to house carpentry, however, it must be remembered that much of the East Coast boom region was built up in lath and plaster construction of rather flimsy if showy type and people here recognize that at least part of their losses should be charged to poor building.

Two Skyscrapers Shattered

The storm wrecked and partly shattered the 15-story Realty Board Building and the 17-story building owned by Highleyman & Galatis, but known by the name of the lessees, the Meyer-Kiser Bank. The latter structure is badly distorted and may prove a total loss, though the attempt will be made to save part of it. Both are unusually narrow, the Realty Building is 45 x 94 ft. and faces west; the Meyer-Kiser 45 x 140 ft. and faces south. Both have steel frames, thin tile and concrete rib floors and 8-in. hollow tile inclosure

(Continued on p. 556)

Small Railroad Plans to Build 78 Miles in Arkansas

The Reader Railroad, a short line in Arkansas, has applied to the Interstate Commerce Commission for authority to extend its present line a distance of 15 miles to a connection with the St. Louis and Southwestern Railway at McNeill, Ark. The company also has asked for authority to construct a new railroad from Hope to Eldorado, Ark., a distance of 63 miles to reach timber and agricultural land and oil fields.

Hanover Typhoid Epidemic Charged to Water Supply

A typhoid outbreak at Hanover, Germany, has reached a total of 1,414 cases and some forty deaths up to Sept. 17, according to an Associated Press dispatch. The outbreak is attributed to the pollution of drinking water by floods.

Slight Damage at Mobile

In a telegram to *Engineering News-Record* Major-General W. L. Sibert, U. S. A. retired, chairman and chief engineer of the Alabama Docks Commission reports the following situation in Mobile:

"Engineering structures under way at Mobile are the Alabama state docks, the Bay Bridge and the U. S. Quarantine Station. None was injured by the storm of Sept. 20. Contractors' equipment at the state docks was damaged to the extent of about $3,000. No damage was done to bridge structures or the causeway. The quarantine station at the mouth of the Mobile River sustained no damage. The fact that the wind was from the north saved the city from water damage. There were no lives lost in the storm on the Alabama Coast."

A request for storm data made to the commandant of the naval district at Pensacola brought only the information that he could supply nothing now because of the press of emergency work. However, *Engineering News-Record* has communicated with other Pensacola engineers and will undoubtedly have data from there for next week's issue.

Topics Announced for Sixth Ohio Water Purification Conference

Topics announced for the sixth annual Ohio Water Purification Conference, to be held at Toledo, Oct. 21 and 22, are grouped under four heads: water treatment, four papers; water supply, one; sewage disposal and waste treatmen, three; miscellaneous, one. There will also be less formal discussions of various problems, chiefly associated with some of the topics named. For details address the Ohio Department of Health, Columbus, Ohio.

Desmond FitzGerald Dead

Began as Railroad Engineer But Early Turned to Water-Works—Had Notable Art Collection

Desmond FitzGerald, oldest of the living past-presidents of the American Society of Civil Engineers, collector of paintings and rare oriental pottery, long a public official of Boston and of Brookline, and a consulting engineer for many years, died at his home in Brookline, Mass., on Sept. 22, in his eighty-first year. After a few years of railway engineering, during which he rose rapidly to a chief engineership, Mr. FitzGerald took up his long term of service on the Boston water-works, where he was a pioneer in water sanitation studies of evaporation and micro-organisms in water and did notable work on dam and reservoir construction. This led naturally to much consulting work, then and later, chiefly on waterworks problems.

Desmond FitzGerald was born in Nassau, West Indies, May 20, 1846. He was educated at the Providence, R. I., high school and at Phillips Academy, Andover. When little more than a lad he began his engineering career as a student in the engineering office of Cushman & DeWitt, of Providence. He could not have been there long, for in 1867 he became axeman on the Indianapolis & Vincennes R.R. at a wage of a round dollar a day. Here he literally began making his mark in the world as he related to the writer ten years ago.

"My motto," said Mr. FitzGerald in substance, "was to do anything I had to do as well as it was possible to do it. I found poor stakes in use and set myself to make better ones: square and well-smoothed for the cut-and-fill figures, which I put on boldly and legibly. When a superior came over the survey line he asked who made the stakes and declared them to be the finest he ever saw. I was promoted to be rear, then front chainman, rodman, and transitman, the latter at $75 a month. I saved most of my wages and bought C.B. & Q. stock"—which habit, the writer then thought, might explain how this engineer became able to acquire the costly paintings and pottery, build the gallery for them and provide a keeper so they could be open to the public daily.

Railway and Water-Works

Three years after beginning as axeman on the I. & V. this young engineer was assistant chief engineer of the Cairo & Vincennes Ry. He then became a division engineer on the Rockford, Rock Island & St. Louis R.R., leaving that work for a brief period on federal river improvement work. His railway work was rounded to a conclusion by the chief engineership of the Boston & Albany, 1871-73.

There followed three decades of notable work on the Boston and Boston Metropolitan water supplies, beginning in 1872 as superintendent of what was then known as the Western Division of the Boston Water-Works, comprising the supply end of the system, and continuing as engineer of the Sudbury Department of the Metropolitan system from 1898 to 1902. During the quarter century that elapsed before this part of the Boston water-works was taken into the Metropolitan water system Mr. FitzGerald designed and built a number of important dams and reservoirs. More notable in the history of American water-works, was his pioneer work on the prevention of water pollution, both legal and physical, on evaporation, and on the biology of water supplies. Through his energy and ingenuity, aided by the Boston legal department, one of the earliest recorded lawsuits to prevent water pollution was won, a suit to prevent the discharge of hotel water closet wastes into Pegan Brook. "The assistant corporation counsel," said Mr. FitzGerald in substance while recounting the reminiscences already cited, "was a stickler for evidence and not satisfied with proof that a sewer led from the hotel to the brook. So I had balls painted and numbered, put them in the hotel water closets and recovered them in the sewer and in the brook. The case was decided on the ground that the act

(*Continued on p. 558*)

Engineering Fifty Years Ago

From *Engineering News*, September, 1876

THE Gilbert Elevated Railway Co., have been enjoined not to build its road along Sixth Avenue, New York City.

* * *

Pittsburgh people are much exercised over what they consider unjust freight discrimination, and are seriously considering the building of a road from that place to some point on Lake Erie, and to connect it with the Baltimore & Ohio, thus giving them a shorter line to Chicago than the present Pittsburgh and Fort Wayne. The new line will be called the Pittsburgh and Lake Erie.

* * *

The long-talked of Lehigh and Eastern Railway, which is to extend from Tomhicken, near Hazleton, to a connection with the Erie at Port Jervis, N. Y., is to be built soon. At a meeting of the directors and stockholders, held last week, President Kase stated that the right of way had about all been secured, and that the work of grading would be immediately begun, and that the road would be in running order during the coming summer. The road will cross Pocono Mountain a few miles north of Stroudsburg, thence pass up the Pennsylvania side of the Delaware River, crossing the same near the point of connection.

St. Lawrence Water Power Plans Outlined

New York State Commission Adopts Terms Under Which It Will Issue Licenses

The New York State Water Power Commission has determined upon the terms which any applicant for a license to develop power in the international section of the St. Lawrence River must accept. These terms were adopted at a meeting of the commission held on Sept. 24. At the present time, there are two applicants for a license, the Frontier Corporation for a single-stage development with a dam at Barnhart Island (*Engineering News-Record*, Apr. 15, 1926, p. 627), and the American Super Power Corporation with four different plans, but favoring a single-stage development (May 13, 1926, p. 786, and July 1, p. 29).

The applicants must have filed an acceptance of these terms before Sept. 30 in order to have their applications considered by the commission when it holds its final hearing on the subject on Oct. 15.

Conditions Briefly Stated

The commission's resolution is a formal adoption in legal terms of the conditions which, on June 29, the state engineer recommended being included in any license. Briefly stated, they are as follows:

The license shall be for fifty years from its date. The licensee must secure approval of other governmental and international bodies of its plan and start construction within three years and must be able to produce at least 500,000 hp. within the next five years, and the total output of 1,200,000 hp., (one-half of the total at the site) as soon thereafter as practicable. A $10,000,000 faithful performance bond must be furnished before starting construction. The licensee must report every expenditure and the commission has power to allow only those items which it approves to be placed on the company's books. The state shall have power to regulate rates and capitalization. The licensee must protect navigation and provide locks for existing navigation routes as well as make provision for lock and other facilities for a future ship canal if required.

At the expiration of the license period all property, in a perfect operating condition, vests absolutely in the state of New York. The state, under certain conditions, may purchase the entire plant at cost, less the amount then in the amortization reserve, plus 15 per cent.

For the privileges granted, the state shall receive (1) an administration charge of $75,000 per year, (2) a cash license charge of $2.25 per horsepower of plant output per year, and (3) annual payment to amortization reserve.

The commission stipulates in its terms that the dams and power houses must be so constructed that there will be on the New York side of the international boundary line a power house capable of controlling the flow of the river and producing at least half of the power which may be generated from the entire development.

Florida Hurricane Destruction

(*Continued from p. 554*)

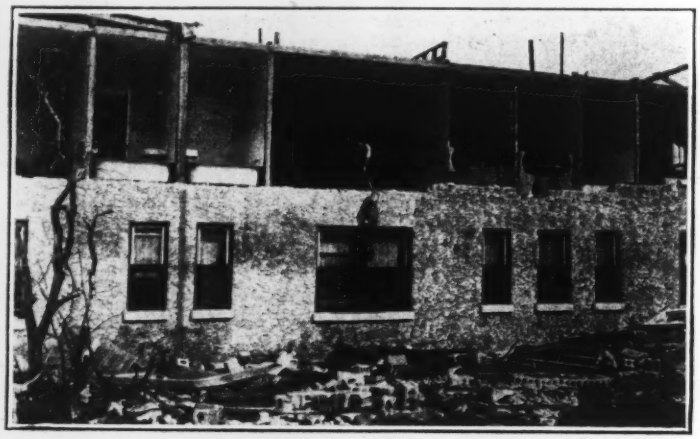
walls. The hurricane blew from the northeast from midnight to six Saturday morning, then after a lull blew from southeast and later southwest till after noon. As both phases were almost equally violent all building exposures thus were equally at risk.

The Realty Board Building is extensively cracked in its walls and partitions in the lower 4 or 5 stories but is apparently plumb. The Meyer-Kiser is substantially plumb and sound for the lower 3 stories thence for 10 stories upward, leans westward nearly 2 ft. at its south front and there bends back again nearly into the vertical. The rear or north face has an opposite lean of about 8 in. without localized bending but with some cracking in the lower part of the wall. This building has been condemned for occupancy and the city has ordered that it be demolished down to the eighth floor after which further examination is to be made.

To Review Steel Plans

Both buildings were put up during the feverish building rush of the summer of 1925. They were supposed to be designed for 20 lb. wind pressure under the city building ordinance as were all but one or two of Miami's high buildings. But in view of the damage which they suffered the steel plans are now to be reviewed. The wind bracing system in both consists of columns and girders with no diagonals but with some knee brackets in the lower stories and in rear wall of the Meyer-Kiser Building. In the front wall of this building the 24-in. girders have remained straight and horizontal while the 12 to 14-in. columns are bent sharply just above and below the girders. The connection angles are correspondingly distorted and a few are cracked in the root, yet they must have been strong enough to bend the columns before failing.

Some small plaster cracks are to be seen in one or two other tall steel frame buildings. The building department



P. & A. Photo.

TYPICAL FAILURE OF BUILDINGS BUILT OF WALL TILE OR CONCRETE BLOCKS

P. & A. Photo.

MEYER KISER BANK MAY BE TOTAL LOSS

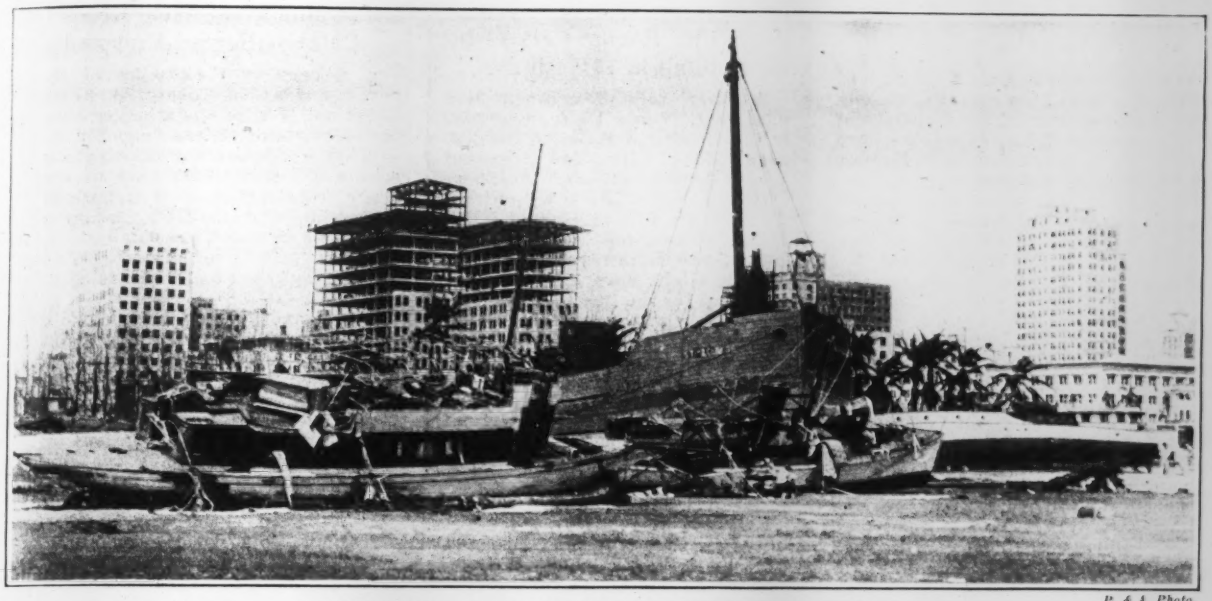
Seventeen-story steel frame structure is badly distorted; substantially plumb and sound for only lowest three stories. Condemned for occupancy

states that no cracks have been found in any of the reinforced-concrete buildings in Miami.

Moorehaven Inundated by Lake

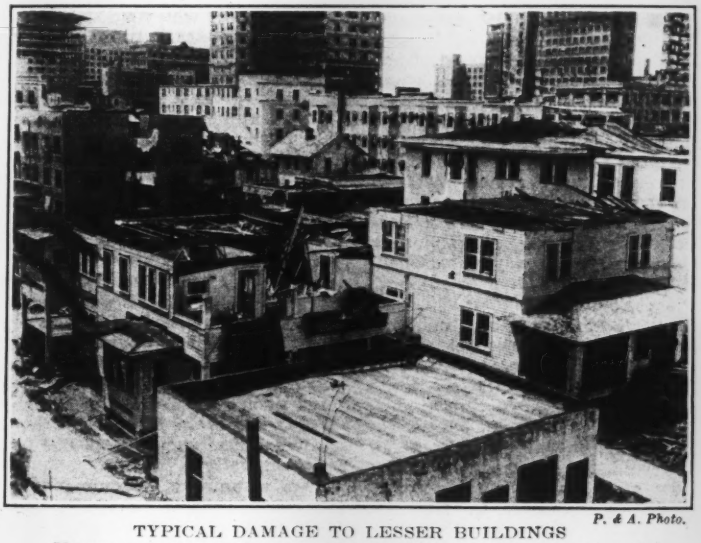
Moorehaven, on the West edge of Lake Okeechobee, is 95 mi. northwest of Miami. The storm arrived there three hours later but displayed the same characteristics and violence. The wind was east in the first phase and southeast to south in the second. Its driving power was such that it lowered the lake water 4 ft. at the east shore and piled it up in the bay-like west end to extra height on a broad shoal fronting Moorehaven, where it ultimately went nearly 7 ft. above normal.

The lake is leveed here to 22 ft. above sea level. Its water level varies from 12 to 14 ft. at the extreme of a dry cycle to overflow over the natural south bank in the rainy season of a wet cycle. The nearly completed St. Lucie canal which in future is to control it has been operated at full available capacity but F. C. Elliot, chief engineer of the Everglades Drainage District, states that because of heavy rains this season following three wet years, the lake stood at El. 18.5 before the storm. Even before the storm rise of the water rain and spray drove in solid sheets into Moorehaven and wrecked much of the town and outlying houses. The overflowing lake helped along by the 15-in. rainfall, completed the havoc. Near Clewiston, a length of muck levee had its top blown off. Thence west 12 or 15 mi. to beyond Moorehaven, the sand and rock leevee was breached at many points some 6 or 8 ft. deep. Out of the two thousand or more people in the Moorehaven district, more than one hundred were lost, most of them out in



P. & A. Photo.

WATERFRONT OF MIAMI AFTER HURRICANE OF SEPT. 18
Water rose 7 ft. from Biscayne Bay, depositing boats on shore. General good condition of steel frame structures evident.



P. & A. Photo.

TYPICAL DAMAGE TO LESSER BUILDINGS
Houses were unroofed, overturned, crushed, or otherwise wrecked or damaged early in the hurricane

the back country or along the roads where they were trying to reach town for safety. Only two or three lives were lost in Moorehaven itself. The state authorities have ordered the town evacuated.

Report on Chicago Street Traffic

According to an advance note regarding the street traffic survey which has been practically completed under the direction of the Chicago Association of Commerce, some of the local troubles include a lack of well-paved streets, disregard of pedestrians' rights, abuses of parking privileges, conflicting traffic regulations and small-town practice in allowing street obstructions which hinder traffic.

A careful traffic count showed that from 7 a.m. to 7 p.m. on an average day the number of persons entering or leaving the loop or business district is 1,693,506.

Assuming that all who enter the region leave again during the day, the streets of this district are called upon to carry 846,753 persons daily or about 25 per cent of the city's population. A vehicle count from 7 a.m. to 11 p.m. showed 314,640 vehicles entering and leaving, of which 72 per cent were private passenger automobiles, but these automobiles averaged only 1.8 passengers per car.

Washington Adopts Pedestrian Traffic Control Plan

The Board of District Commissioners of Washington, D. C. has adopted traffic regulations whereby pedestrians must follow electric control signals in crossing intersections. While arrests will not be made for violation of the pedestrian control regulation for at least six months, it is planned to have policemen stationed at the intersections to hand offenders pink cards warning them that they have violated a traffic regulation. At the end of a reasonable educational campaign, arrests will be asked. No penalty is provided in the pedestrian control regulation itself, but the traffic act provides that violators of any provisions or any section or paragraph wherein a penalty is not specifically provided shall be punished by a fine of not less than $1 nor more than $300, or imprisonment of not more than 10 days.

The pedestrian control is only on streets where traffic is controlled by electric traffic signals. Pedestrians are given a safe chance to cross every 35 sec.

To Stop Pollution of Fox River

By a majority vote of voters in the drainage area of the Fox River, Illinois, a sanitary district is to be organized to check the increasing pollution of the river and its tributaries by sewage and wastes, as well as to protect and preserve fish and to maintain a water supply for the growing population in the valley. Under the State law, the county judges of the seven counties included will appoint a board of five trustees.

Funds for the work of the district will be raised by imposing a tax of 0.5 per cent of the assessed value of property within the district.

Engineer Trade Commissioner Appointed to Orient

Appointment of Joseph H. Ehlers, of Hartford, Connecticut, as engineering trade commissioner of the Department of Commerce at Tokio, Japan, has been announced by the Bureau of Foreign and Domestic Commerce.

Mr. Ehlers was born at Hartford, Conn., and was educated at Trinity College, where he received the degrees of B.S. and M.S. He attended the University of California and Cornell University, where he pursued graduate studies leading to the degree of master of chemical engineering. After leaving college he was employed in mining engineering work in Alaska. At the conclusion of that work he departed for China, where he joined the faculty of the Pei Young University at Tientsin, as professor of structural engineering. Later he entered the employ of the Asia Development Co. in connection with the Yellow River project. For some time he was editor and publisher of an engineering magazine devoted to the promotion of American and Chinese cooperation in development projects and while in the Orient he served in an honorary capacity as counsellor to the Chinese Ministry of Communications.

Toll Highway May Be Substituted for Proposed Railway

The project of constructing a railway to open up the central Manitoba mineralized area has been abandoned for the time being at least. The Manitoba Central Railway, formed for the purpose, has withdrawn its application for a charter. It has been arranged that the line would be operated by the Canadian National Railways, but the engineers of the C.N.R. reported, after a survey, that there was not sufficient traffic in sight to warrant the construction. A proposal to construct a toll highway suitable for motor traffic from some point on the Winnipeg River into the mining region is to be submitted to the Manitoba government.

There has been organized recently the Central Manitoba Mines, Ltd., under the law of Manitoba, to carry on the operations in this region of the large British mining company of John Taylor & Sons. In the last two years this company is reported to have spent about $1,000,000 in developing the property.

Ford, Bacon and Davis, Engineers for Pontchartrain Bridge

Ford, Bacon and Davis, New York City, are the engineers for the toll bridge across Lake Pontchartrain which as planned will give New Orleans a highway exit to the north and east. They prepared all plans and estimates for the structure which will consist of 5 miles of reinforced-concrete trestle and 10 miles of fill and timber-trestle approach and also supervised the contract letting as reported in these pages Sept. 16. Financing the project is to be carried out by bonds offered last week by a banking syndicate and consisting of $3,500,000 in first mortgage and $2,000,000 in debenture securities.

Sioux City Region Gets 14-In. Rainfall in 13½ Hours

A 14-in. rainfall between 2:30 p.m. Sept. 17 and 4 a.m., Sept. 18, in the vicinity of Hull and Boyden, near Sioux City, Iowa, caused severe flood conditions. At Sioux City, the Floyd River was within 2.9 in. of its 1892 mark, and E. W. Dunn, district engineer for the Iowa State Highway Commission, says it might have exceeded that mark but for the fact that the Missouri River was low, while in 1892 it was high. Many miles of railroad track were washed out, and much damage was done to farm property, highways, railway and highway bridges and to property at Hawarden and Sioux City.

(*Continued from p. 555*)

authorizing Boston to take 'water granted to the city the right to the water in its then state of purity, whereas the hotel had turned water closet wastes into the brook subsequently."

Later, Mr. FitzGerald worked out schemes for the diversion of sewage from the Boston water gathering grounds, the city in two or three instances contributing to the cost of diversion and of treating the sewage before its discharge into other waters. He also introduced stripping organic matters from new reservoir sites, to prevent color, tastes and odors (long before current water treatment methods were in vogue) and diverted colored swampy waters from some of the Boston storage reservoirs. The pioneer water laboratory, already mentioned, aided in the studies leading to some at least of these measures.

Another notable series of studies at the Chestnut Hill reservoir was the one that led to the paper on "Evaporation" that won for Mr. FitzGerald the Norman Medal in 1887 (Transactions, Am. Soc. C. E., Vol. XV, p. 581). Six years later this medal again went to Mr. FitzGerald, for his paper on "Rainfall, Flow of Streams, and Storage" (Transactions Am. Soc. C. E., Vol. XXVII, p. 253).

Many consulting engagements of Mr. FitzGerald as well as other incidents in his life not here mentioned are noted in a sketch of his life written by Charles W. Sherman, then assistant to Mr. FitzGerald, on the latter's accession to the presidency of the American Society of Civil Engineers (*Engineering News*, Jan. 19, 1899, p. 37).

In his home town of Brookline Mr. FitzGerald took active part in church, civic and municipal affairs.

Briefly viewed, it may be noted in conclusion, one of Mr. FitzGerald's greatest claims for recognition was his large collection of paintings and Korean and Chinese pottery, made accessible to the public for many years past in a gallery connected to his home built in 1913. Here were scores of paintings by American and European artists, the latter including a goodly number by Claude Monet, and the former dozens by Dodge MacKnight.

Large Mileage of Wide Roads for Chicago Region Proposed

A mileage of 174.4 miles of 40-ft pavements in Cook County, Ill., 57 miles additional of wide street connections in the outskirts of Chicago and 250 miles of 20-ft. roads are the principal items in the $32,000,000 program of emergency construction just reported to county highway officials by an advisory committee in which practically all official and private organizations interested in highways and traffic relief were presented.

The committee was headed by D. H. Burnham, president, Chicago Regional Planning Association, which organization loaned its engineers to do the detailed work of investigating the existing conditions of traffic, reports available and programs of the various jurisdictions and then placing the results in tabular and map form for action by the full committee of 27. Relief had generally been considered available only through widening but the committee reported that a proper combination of the following various means was necessary: Separation of grades at intersections, widening existing pavements to 40 ft., building new 40-ft. pavements, widening intersections, building new 20-ft. pavements, widening shoulders and bridges in preparation for future widening, and widening and improving city street connections.

Of this program the state highway department officials have accepted the state's share amounting to $3,735,500 and will proceed at once to put the work under contract. The municipalities' share is $6,535,000 which represents special assessment work, much of which is in some stage of procedure up to construction.

The Forest Preserve District has no available funds for its share of $538,000 and the county will probably include the districts' quota with that of its own which amounts to $21,281,500.

A bond issue of $15,000,000 is to be voted upon Nov. 2 and the balance can be obtained from the current highway tax which nets about $3,000,000 for new roads annually.

The committee recommended that pavement widened to 40 ft. and new 40-ft. pavement projects be given priority in the construction program.

First Pan-American Conference of Public Health Directors

The first Pan-American Conference of National Directors of Public Health will be held in Washington, Sept. 27-29, under the auspices of the Pan-American Sanitary Bureau, of which Surgeon-General Hugh S. Cumming of the U. S. Public Health Service is director. The conference will discuss the Pan-American sanitary code adopted at Havana several years ago, and already approved by seven of the American republics. It will also take up the program for the eighth Pan-American Sanitary Congress, to be held at Lima, Peru, Oct. 9-19, 1927. Another subject for consideration will be the foundation and dedication of a Pan-American bureau library.

Schwab Heads A.S.M.E.

Charles M. Schwab, chairman of the board of the Bethlehem Steel Corp., has been elected president of the American Society of Mechanical Engineers, according to an announcement made at a meeting of Virginia State branch of the society in Richmond Sept. 28. Mr. Schwab has been a member of the society since 1899.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Meeting, Buffalo, N. Y., Oct. 11-14, 1926.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, Pinehurst, N. C., Nov. 8-12, 1926.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

THE ASPHALT ASSOCIATION, New York City; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

HIGHWAY RESEARCH BOARD, OF NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Dec. 2 and 3, 1926.

The International City Managers Association at its annual meeting held at Colorado Springs Sept. 21-23 elected as president Fred H. Locke, city manager of Grand Rapids; and as vice-presidents A. M. Wilson, Colorado Springs, T. S. Scott, Niagara Falls, Ont., and E. E. McAdams, Waco, Texas. Dubuque, Iowa, was selected for the 1927 convention.

The Kentucky-Tennessee Section of the American Water Works Association will hold its next meeting Jan. 19 to 21, 1927, at Memphis, Tenn.

The American Welding Society at its fall meeting at Buffalo, N. Y., on Nov. 17 to 18 (announced in these columns Aug. 19, p. 315), will have an extensive exhibit of apparatus and supplies. At the technical sessions there will be papers on: "The Design and Development of Welding Apparatus," "Welding on the Railroads," "Welding of Locomotive Parts," "Welding Science at Engineering Schools" and "Arc Welding in a Gaseous Atmosphere." A special joint meeting will be held of the American Bureau of Welding and the sub-committee on specifications for welding wire.

The Colorado Society of Engineers, at Denver, Sept. 10, opened its fall season with a series of short talks and discussions on local subjects which included: "Public Relations of the Engineer," by John E. Field, consulting engineer; "Local Transportation Problems," Harry Class, attorney for Motorway Transportation Co.; "Problems of the City Engineer," Charles A. Davis, sewer department; "The Flood Control Problem," L. E. Bishop, consulting engineer; "Water Supply Problems," D. D. Gross, chief engineer, Denver Municipal Water Co.; "Moffat Tunnel Problems," C. A. Betts, office engineer, Moffat Tunnel Commission; "City Zoning Problems," F. W. Ameter, engineer for Denver Zoning Commission.

The Tennessee Branch of the Associated General Contractors at its recent meeting at Nashville elected officers as follows: president, V. E. Schevenell, Memphis, also president of the Memphis chapter; vice-president, J. E. Garvin, Knoxville; and treasurer, A. W. Atwater, Chattanooga.

The Cincinnati Engineers Club opened its fall meetings Sept. 16 with papers on "Air Conditioning and Cooling," by H. B. Matzen, Newark, N. J., and "Insulating Materials and Ventilation," by J. H. Bracken, Chicago.

The Engineers Society of Milwaukee opened its fall season Sept. 15, the meeting being arranged by the local section of the American Society of Refrigerating Engineers (one of the affiliated societies of Milwaukee), and a paper on "Why Water Treatment Is Necessary for Ice Making" being presented by A. J. Autenreith, vice-president of the Middle West Utilities Co. The annual meeting will be held Oct. 20. Robert Cramer is secretary of the society.

Personal Notes

HOWARD J. TEAS, who for the past two years has been field engineer for the Portland Cement Association in eastern Missouri, is now associated with I. Newton Carman, Inc., surveyors and engineers, at Malverne, N. Y. Mr. Teas was formerly employed for several years by the Illinois and Missouri state highway departments.

JOHN J. HARTY, who for a number of years has been associated with Monks & Johnson as engineer in charge of structural designing and drafting, announces the opening of an office for the practice of architectural engineering at 25 Huntington Ave., Boston, Mass.

G. H. EAGLE, of Wooster, Ohio, who graduated last June from Ohio State University, has been appointed sanitary engineer in the engineering division of the Ohio State Department of Health in charge of school sanitation; during the summer he served in the engineering department of Wayne County, Ohio.

EDWIN WORTHAM announces the association with him, in general consulting engineering, of K. S. WINGFIELD formerly with Murray & Flood of New York, the offices of the new firm being in the Grace-American Building, Richmond, Va.

MAJ. HAROLD C. FISKE, Corps of Engineers, has been relieved from duty at Chattanooga, Tenn., and ordered to Camp Lewis, Washington, for duty with troops.

MAJ. LINCOLN B. CHAMBERS, Coast Artillery Corps, stationed at Fort McArthur, Calif., has been transferred to the Corps of Engineers and ordered to Memphis, Tenn., for duty in connection with the improvement of the Mississippi River in the first and second districts.

THE SWANK-TANNER ENGINEERING CO., a partnership composed of C. E. Swank and Paul A. Tanner, civil engineers, has been dissolved. This firm has had an office at Lake City, Fla., conducted by C. E. Swank, and an office at Charleston, Mo., conducted by Paul A. Tanner. Mr. Tanner will continue an engineering office at Charleston, Mo. The Lake City office has been abandoned, Mr. Swank having been appointed city manager of Lake City, Florida.

ARTHUR H. BLANCHARD, professor of highway engineering and highway transport at the University of Michigan, will sail Oct. 2 for Europe to devote several months to an investigation of highway engineering, transport and traffic control problems.

Obituary

JAMES HOLLIS WELLS, civil engineer and architect, died Sept. 24 at his home in Jersey City, N. J., aged 63 years. Mr. Wells was general inspector of pavements in New York City from 1887 to 1889 and then for a number of years was connected with Clinton & Russell of that city. For some years he also directed the department of architectural engineering in the *New York Architect*. He was an Englishman by birth but came to the United States as a boy; he graduated in civil engineering in 1885 from Lehigh University.

GEN. HENRY T. DOUGLASS, at one time chief engineer of the Baltimore & Ohio R.R., died July 20 at the age of 88 years.

CLIFFORD DE WITT PERKINS, division engineer of the Danbury division of the New York, New Haven & Hartford R.R. and of the Central New England R.R., died suddenly of heart disease in Stamford, Conn., Sept. 25. Mr. Perkins was born in Northampton, Mass., and had been with the New Haven railroad for 48 years. He had served the road as bridge supervisor, roadmaster of the Shore Line and New York Divisions, division engineer of the New York Division and assistant engineer of maintenance-of-way for the entire system.

JAMES E. ALLISON, former member of the Public Service Commission of St. Louis, Mo., died in St. Louis, Sept. 19 at the age of 61 years. In recent years Mr. Allison specialized in the valuation of public utility properties, on cases before the Interstate Commerce Commission and various state commissions and in Mexico and Canada. For the past ten years he was head of James E. Allison & Co., consulting engineers, St. Louis.

Construction Equipment and Materials

A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

Trade-Ins from the Manufacturers' Viewpoints

Used Equipment Cannot Be Rebuilt Without Loss in a New Equipment Plant—More Local Used Equipment Dealers Needed

FROM time to time *Engineering News-Record* has received comments and questions relative to trade in practices in the construction machinery field. These have indicated a growing realization that the industry, including contractors, manufacturers and distributors, must formulate some definite ideas on the results of present practices and determine what, if any changes can be made that will retroact more favorably to all concerned. With this idea in mind, a letter was sent to a majority of the leading manufacturers and distributors of construction equipment asking for their views on the question. The following remarks are based on the results of this survey.

Trade-ins, the practice of turning in used equipment to cover a part of the purchase price of a new piece of machinery are the result principally of (1) obsolescence, (2) so-called legitimate wear from use, (3) the desire for equipment of a different capacity, (4) a contractor changing the type of work he has previously been doing and (5) the desire for the newest models of equipment, a sort of quasi-obsolescence. It will be noted that these are all natural and logical reasons that are intimately tied up with progress and development in the field. Trade-ins, therefore, are inevitable and the problem is one of regulation rather than elimination.

Trade-ins have become an accepted practice in the automobile industry and a procedure for handling them has been set in motion that seemingly works satisfactorily. Several manufacturers of construction equipment, however, ventured the opinion that the automobile and construction equipment industries were not exactly comparable, at least at the present time. On the other hand, they felt that a growth in competition and saturation in the construction equipment field would present trade-ins in a somewhat different light just as it has in the automobile industry. One manufacturer seemed to hit the nail on the head when he said, "Construction equipment is vastly different from automobiles; a number of good people can use rotten automobiles but you don't find good contractors using rotten machinery."

Manufacturers' Viewpoints

The manufacturers and distributors as a unit are against trade-ins. They all want to render the maximum service to the industry but know from experience that the handling of second-hand equipment cannot be carried on profitably as an adjunct to the manufacture and sale of new equipment. A rather general agreement was seen in the replies from the manufacturers as follows:

(1) We do not willingly accept trade-ins.

(2) When we have made trade-ins, we have usually lost money.

(3) Our shops are not designed for rebuilding work.

(4) Manufacturers should not go into the second-hand machinery business.

(5) It would be a fine thing if each territory had a reliable used equipment dealer.

An Important Question

That the question of trade-in practices in the construction equipment field is of considerably more than ordinary interest is indicated by the replies to a form letter sent to representative manufacturers and distributors by "Engineering News-Record." When it is remembered that replies to a letter of this type average at most 15 per cent of the total letters sent, the 41 per cent of replies from the manufacturers and the 38 per cent of replies from the distributors to this letter on the trade-in question are rather remarkable. The letters averaged 1½ pages in length and were signed by the presidents, vice presidents and general managers of the companies. It is not on trivial matters that so many of these executives reply so fully.

(6) We only make trade-ins on our own equipment.

(7) We do not accept as trade-ins any obsolete equipment.

(8) Taking trade-ins makes necessary two complete sales with the possibility of loss on both.

(9) We do not encourage trade-in practices for our distributors.

(10) Customers' ideas as to the cash value of old machinery are invariably high.

The distributors as a whole concurred on the above points and in addition had several opinions of their own. The following opinions of distributors are taken at random and do not represent a concensus of opinion, as do those given by the manufacturers:

(1) Distributors have been forced to be a party to trade-ins by "desk merchants" who often take used equipment at a loss in order to gain entry into the equipment field.

(2) Used machinery business cannot be conducted in connection with the new machinery business.

(3) The distributor stands a good chance to lose since he is dealing in an unknown quantity—the final selling price of the used equipment—while both the contractor and the manufacturer are secure since they know immediately how they are coming out.

(4) We are absolutely against the practice so far as heavy machinery is concerned, but think it is O.K. on small equipment of the type that the distributor handles himself.

(5) A distributor by putting two old machines together can make one good one.

(6) A policy of taking trade-ins leads contractors to believe that any new equipment which they buy will be an asset when it becomes old.

(7) The distributor will continue to be forced to deal in second-hand equipment.

Trade-Ins A Losing Practice

The manufacturers of construction equipment do not favor trade-ins, because they invariably lose money on them. In line with the service a manufacturer is supposed to render to the construction industry, he is obligated to overhaul all second-hand machines before reselling them. He cannot jeopardize his name by selling inferior equipment, even if it is used-equipment. Reconditioning equipment is an industry in itself, and will not fit into a shop designed for the manufacture of new equipment. One manufacturer states: "In shops like ours, that are designed and operated for quantity production of new standard machines, the rebuilding of a few machines would upset the production schedule of new machines going through the shop. If we accepted trade-ins it would be necessary for us to have entirely separate shops as the first requisite toward a profitable pursuit of the enterprise." Another manufacturer states: "We have taken in a few machines at different times, especially when we had extra time in the shop to rebuild. Our cost figures on the rebuilt job are pitiful, so far as anything we get out of the transaction is concerned." Still a third manufacturer says, "It is true that the manufacturer is probably in better shape from a knowledge point of view to rebuild than is any one else. On the other hand, he is not usually equipped for that sort of work. It costs him a lot of money to put a few special jobs through."

A manufacturer who takes trade-ins of machines of standard design and up-to-date models has considered the question of shipping the second-hand machinery into some central point where it can be rebuilt. He has found that the necessary selling price of the rebuilt equipment is prohibitive to sales. His only recourse was to give the contractor less for the machine than it was actually worth which he considered poor business. An alternative is to raise the price of the new equipment sufficiently to cover any loss. But as another manufacturer states: "An exceptional allowance for a second-hand machine is merely equivalent to giving a secret rebate, which, coupled with excessively high selling prices on the new machinery, we consider makes a very unstable method of doing business."

Besides the loss attendant to reconditioning equipment in a plant designed

for the turning out of new equipment, the manufacturer sustains a loss in his selling operation when he is concerned with trade-ins. "It takes just as much effort, energy and sales expense to sell a second-hand machine as it does a new machine, which means that we must really sell two machines in order to get one sale," is a common opinion of several manufacturers.

Need For More Second-Hand Dealers

The manufacturer, then, is finding trade-ins unprofitable, largely because he is not equipped to take care of the reconditioning, and becauses his main function is the selling of new equipment. Although one manufacturer states, "There are plenty of dealers in second-hand machinery, and as a rule they will pay more for a piece of used equipment than will a reqtable manufacturer," this obviously is not universally true, else so much second-hand equipment would not be offered to manufacturers as part payment on new equipment. Another manufacturer comes closer to the general consensus of opinion — "Manufacturers cannot deal successfully in used machinery, and it would be a fine thing if each territory had a reliable used equipment dealer."

"Because of our being manufacturers," states another, "the purchaser seems to expect to get a machine as good as a new one when he buys from us regardless of the price that he pays. This is not the case when he buys a machine from a second-hand dealer or from another user." A distributor, thinking along the same lines, replies. "If we had a few more big companies specializing in purchasing old equipment, who would buy from all distributors, it would simplify the situation to a great extent."

Manufacturers Recognize Contractors' Viewpoint Toward Trade-ins

Contractors whose business is growing need machines of larger capacity before their existing ones wear out. Many contractors frequently change over from one type of work to another, which necessitates buying new equipment and disposing of old. Then there is the serious matter of obsolescence before the machine is worn out, caused by improved models being placed on the market. All these factors make it necessary for the contractor to periodically dispose of his existing equipment, and he obviously cannot sell at a loss each time. The replies of the manufacturer indicate that they realize this, and while being unable to purchase the equipment themselves, they are using various methods to help the contractor find a buyer.

Some manufacturers without charge assist owners of the equipment they build in finding buyers for their second hand machines. The contractor must however deal directly with the buyer and not through the manufacturer. In some cases manufacturers' salesmen attempt to dispose of the contractors equipment for him; others list second hand machines available and refer prospects to the owner. A manufacturer of power shovels states that the many revolutionary changes in machine design in the past ten or fifteen years have forced the contractors to periodically sell their equipment, since they cannot afford to operate the obsolete models. This manufacturer believes that the local machinery dealers in the various cities provide the best means of the disposal of this equipment, since these parties will pay to contractors a higher price than can the manufacturers. Also, the transactions are of a cash nature, which are more desirable than even a somewhat larger credit on the purchase of new machinery. "However," he resumes, "there is an earnest effort on the part of our sales organization to dispose of old machinery on the customer's account before taking an order for a new machine involving a trade."

Some Trade-In Practices

Although some manufacturers do not take trade-ins under any circumstances, there are others who feel that some conditions warrant an allowance on old equipment. There is a general policy on the part of all manufacturers that they will not accept competitor's equipment or even their own equipment if the model is obsolete.

When one manufacturer's representatives report a sale contingent on a trade-in, he is guided by four conditions: (1) That the company or individual must be an old and good customer; (2) The trade-in must be equipment of his manufacture; (3) It must not be obsolete; (4) It must be traded in at his appraisal value, which is sufficiently low to cover all expense of rebuilding and resale at a figure from $1,000 to $2,000 under the present list price. In another instance a manufacturer has taken as trade-ins machines upon which improvements on subsequent models made the work done by the older machines of an inferior quality. The first machines may be turned in at fixed trade-in value, irrespective of life or condition; the manufacturer scraps them.

Several manufacturers contended that it was good business to take in machines that were not legitimately worn out. They felt that the negative advertising value shown by such equipment was enough to warrant considerable expense in getting it off the market, rebuilding it, and selling it again. "We limit our trade-in policy to such machines—and every manufacturer has them in every territory—that are doing no particular credit, due to abuse, neglect or early engineering mistakes on our part. Our allowances for the different years' models of machines are generally fixed, regardless of conditions. We feel that the manufacturer must be responsible for each unit which leaves his shop, and his responsibility is ended only when such a machine is out of use, either from obsolescence or depletion from legitimate wear; that it is out of service prematurely is a reflection on his product."

However, in all of these cases where trade-ins are sometimes made, the rather general governing condition is that the used equipment must be practically sold before it is accepted as part payment on the new equipment.

Business Notes

Midland Steel Products Co., Cleveland, a large manufacturing concern for automobile frames and pressed steel products in Cleveland and Detroit, is through its development department, looking for some new pressed steel products to be manufactured as an addition to its line. The material contemplated is pressed steel of ¼ to ⅜ in. thickness. The article will be either sold on a royalty basis or the company will buy it outright.

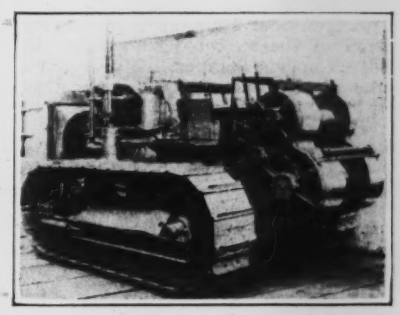
McMyler-Interstate Co., Cleveland, Ohio, has announced that it will reenter the structural steel fabricating field, coming into the market with plant facilities for producing 800 to 1,000 tons per month. Thirty thousand sq.ft of floor space, at the Bedford, Ohio, plant of the company will be devoted to this work. During former years at times when the company was in the structural steel market, both fabrication and erection were undertaken. Under the present arrangement it is planned to devote entire attention to fabrication and not go into the erection end of the business at all.

Lawrence E. Buzard, general sales manager, Fate-Root-Heath Co., Plymouth, Ohio, died in Cleveland, Ohio, September 12 after a brief illness following an operation for appendicitis. Mr. Buzard attended Ohio State University and came to the Fate-Root-Health Co. in 1920.

New Developments

Double-Drum Winch Developed for Logging Operations

Used as an attachment for the caterpillar "Model 60" in Pacific northwest logging operations is a double-drum winch recently perfected by the Willamette Iron & Steel Works, Portland, Ore. The equipment is especially designed to facilitate handling logs on steep mountain grades, in reaching over



windfalls, and operating over muddy ground.

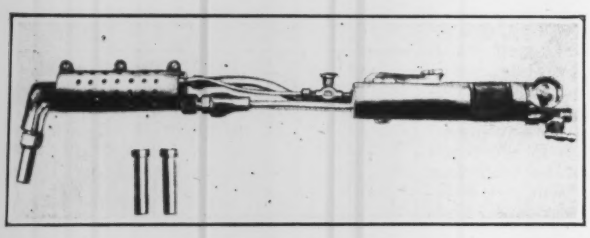
The drum works independently of the tractor, in no way interfering with the drawbar service. The main or hauling drum has two sets of gearing, high and low. A large proportion of pulls can be accomplished in high gear, thereby speeding up the operation. One drum

is equipped with high-speed gearing so that it is suitable for hauling back the main cable. It also has sufficient power for returning drag-line scrapers.

Both drums have ample capacity to operate efficiently at distances of 700 to 1,400 ft., depending on the size of cable used. Operation of the double drum is acomplished entirely from the tractor driver's seat. The haulback drum has an average speed of 528 ft. per minute and carries from 1,600 to 2,000 ft. of line.

New Torch for Metal Cutting With Illuminating Gas

Tests recently made by the General Electric Co. showed that illuminating gas was much more economical in metal cutting than hydrogen or acetylene, the two gases in most general use today. This is especially true for machine cutting. In hand cutting the nature of the work will necessarily determine the gas used for preheating, and the only particular class of work in which acetylene is superior to illuminating gas is rivet cutting or similar operations where the preheating time is an appreciable share



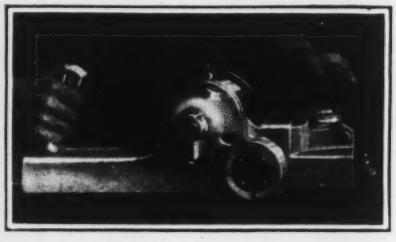
of the total time required for the operation.

Metal cutting with a torch consists of two operations: First, the metal is brought up to a temperature at which it will readily burn when exposed to the action of pure oxygen. Second, the pure oxygen jet is released and by moving the blow pipe in the desired direction a continuous cutting or burning process takes place. In order to achieve this result, the Alexander Milburn Co., Baltimore, Md., has co-operated with the General Electric Co. to produce a new torch that will use oxy-illuminating gas. The preheating flame is composed of oxygen and illuminating gas and surrounds the pure oxygen cutting jet orifice. In this manner, the preheating flame always precedes the cutting jet and brings the top edge of the metal up to the burning temperature at which it will readily burn in pure oxygen. The torch is equipped with a superheater, located in the perforated section of the torch shown in the illustration. The function of this superheater is to raise the temperature of the illuminating gas and oxygen prior to combustion. The higher flame temperature results in a quicker start and greatly facilitates hand-cutting operations. The effect of the superheat on the oxygen cutting jet is to reduce its density, thereby permitting a higher pressure to be used economically. Information on this torch and process was supplied by F. P. Wilson, Jr., manager's staff, Schenectady Works, General Electric Co.

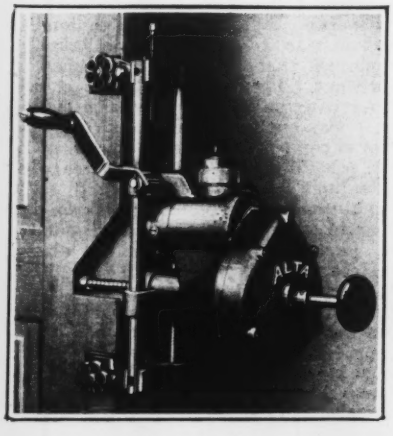
Two New Electric Hand Tools

An electric hand plane and an electric door mortiser are being manufactured by the Wappat Gear Works, Pittsburgh, Pa. Both have been designed for speed of operation and accuracy of results. The power unit on both tools is a ¾ hp. motor operating from any light socket and using either a.c. or d.c.

The cutting by the hand plane is done



by a jointer head driven by gears from the motor. A short shoe at the front of the plane and just ahead of the cutter can be adjusted so as to regulate the depth of cut. A graduated dial at the base of the knob enables the operator to set for any cut from 0 to ¼ in. This adjustment is unique in that it may be made while moving the plane forward and backward along the material and thus making it possible to vary the depth of cut and smooth out humps and hollows in one stroke. Another feature is the bevelling attachment which can be set to cut accurately any required bevel on the edge of a door or sash. The body of the tool is aluminum and the total weight is 19 lb. The steel blades in the cutter are easily removable for sharpening. The cutter shaft is mounted in dust-proof ball bearings.



The outstanding feature of the mortiser is the fact that when installing door locks it cuts for the face-plate as well as for the cylinder. Positive adjustable stops are provided for regulating the length and depth of the mortise. Twelve sizes of cutters, ranging from ⅜ in. diam. to 1⅝ in. diam., are provided to suit the size of the lock. The cutter screws into the end of a long spindle which is fed into the door by light pressure of the right hand and while revolving at high speed is worked up and down by means of a crank handle in the left hand. The machine is, therefore, under the control of the operator at all times which feature is essential where nails are apt to be encountered. It is claimed the tool is free from vibration and, therefore, very sensitive, enabling the operator to detect obstructions and regulate his feed accordingly. The cutter spindle is mounted on roller bearings and the gears run in grease.

New Publications

Centrifugal Air Compressors.—GENERAL ELECTRIC CO., Schenectady, N. Y., has issued a folder, GEA-233, describing its single-stage centrifugal air compressors for use in ventilating mines, tunnels, etc., for aeration and agitation, blowing, pneumatic conveying and exhausting and boosting service.

Segmental Pipe Construction—WALTER C. PARMLEY, consulting engineer, 1270 Broadway, New York City, has issued a 68-p. booklet describing the Parmley system of reinforced-concrete segmental pipe. The material used, the manufacturing process, and the construction work required are described in a preface. Following this, drawings and tables are given for different sizes of pipe, after which some 10 pp. are devoted to pictures of the manufacturing methods. The remaining 40 pp. of the booklet are devoted to construction views with detailed captions explaining each.

Concrete Admixture.—CELITE PRODUCTS CO., Los Angeles, has issued a new bulletin No. 325 describing Celite as used as an admixture for concrete. The bulletin gives technical data on the effect of silicious admixtures in increasing the workability of concrete while a summary of some tests by different laboratories on the compressive strength of plain concrete and concrete in which Celite was used, is also given. Directions are given for the use of the product, including percentages recommended for various concrete mixtures.

Road Rollers—GALION IRON WORKS & MFG. CO. has issued a 14-p. catalog describing its four-cylinder motor roller, giving illustrations and descriptions of the principal details and describing its use and operation.

Gasoline Engines.—WAUKESHA MOTOR CO., Waukesha, Wis., devotes its new 50-page booklet, No. 4225, to its four-cylinder gasoline power unit for industrial purposes. The first ten pages are devoted to general specifications, illustrations and notes on installation, operation and lubrication of the power unit. The balance of the booklet, some forty pages, is devoted to page illustrations of different manufacturers' construction equipment upon which the Waukesha power unit is used.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Weekly Construction Market

VOLUME of contract letting and work soon calling for bids, continue well ahead of the corresponding period of 1925, and this with the year three-quarters gone, according to *E. N.-R.* statistics.

Despite the substantial gain in engineering operations, the cost level for the country, as a whole, is only 3 per cent above this time last year.

Revenue freight loadings, all Class I lines, have held above the million-cars-per-week level (weeks containing holidays excepted) since early in May. It must be remembered that more than a quarter of this freight consisted of construction materials. Cumulative loadings Jan. 1 to date, eclipse any other year on record.

A favorable outlook appears in most of the other basic industries.

THIS WEEK'S CONTRACTS—WEEK AGO—SAME WEEK LAST YEAR

The money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
Sept. 30, 1926	$23,317,000	$34,994,000	$58,311,000
Sept. 23, 1926	20,896,000	30,786,000	51,682,000
Sept. 24, 1925	24,934,000	17,918,000	42,852,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date			
1926	852,660,000	1,325,665,000	2,178,325,000
1925	803,104,000	1.051,526,000	1,854,630,000

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb	$3.34	$3.80	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	$3.75
Structural rivets, 100 lb	4.20	3.80	4.65	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb	3.24	2.80	3.38	2.60	2.87½	3.77½	2.95	3.25	2.50
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	54%	51%	54.25%	41%	—49.7@54.1%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	52.60@53.60	45.25	54.00	49.20@50.20	53.00	64.00	50.00	55.00	55.00
Concreting Material									
Cement without bags, bbl	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd	1.75	1.90	2.35	1.60	1.65	1.90	1.80	1.50	1.50
Sand, cu.yd	1.00	1.60	2.00	1.40	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	62.00	34.00	56.00	40.50	38.25	34.75	27.00	23.00	50.00
Lime, finishing, hydrated, ton	18.20	23.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.10@3.00	1.50	1.85	2.25	+1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.40@22.40	10.50	14.10	12.00	13.75	9@10	15.00	15.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	075	.076	.075	.....	09	.10
Hollow partition tile 4x12x12, per block	.1112	.0895	.112	.075	.076	.075	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal	.87¾	99¾	1.18	.90	.96¾	1.10	—1.01	1.12	1.03
Common Labor									
Common labor, union, hour	.90⅝	.30	.....	87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	30@.50	82½	45@.60	40@.45	.50	50	30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor—Cement and concrete laborers' rate, $1.06¼; building laborers, 90⅝c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Sept. 2 the next on Oct. 7.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) and shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 flr. common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.156). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, less-than-carload lots.

Statistical Analysis Shows Growing Stability in Road Lettings

Close Adherence to Estimated Normal Since 1920—Contract Values Predicted for Last Quarter

IN RESPONSE to a growing demand *Engineering News-Record* is making a statistical analysis of its contract-value figures covering the last fourteen years.

Because of their apparent consistency, the road contract values were chosen for the initial study. The results are given briefly in the article which follows. Next to be examined are the values of contracts awarded for industrial buildings, results to be published in the Oct. 14 issue. The further studies will be announced in *Engineering News-Record* in advance of their appearance.

This work is being undertaken not alone for economists in the construction industry. Its practical usefulness is intended to extend to the salesmanager as well as to the statistician.

To assure results of intimate as well as of the broadest value, criticism and suggestions are invited from men who are interested either in construction or in statistics generally.

You are cordially invited to watch these studies as they appear in *Engineering News-Record* and to send all comments that occur to you to Construction News Editor, *Engineering News-Record*, Tenth Ave. at 36th St., New York, N. Y.

E. N.-R. Statistics of Road Contracts as Related to Normal Growth, Seasonal and Accidental Influences

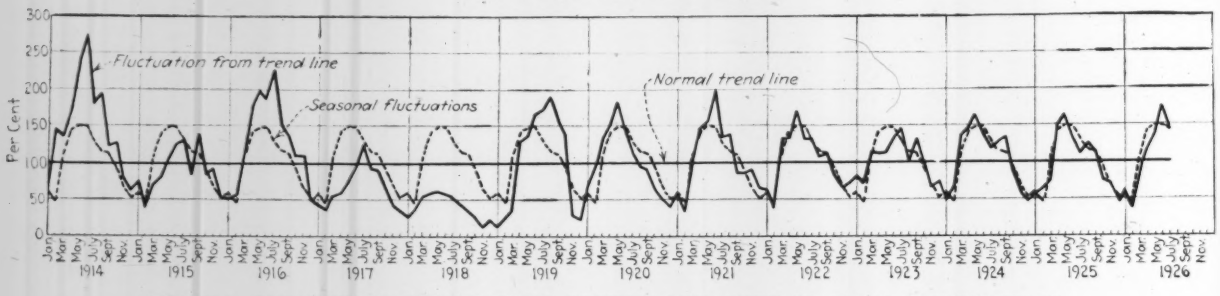


CHART I—PERCENTAGE FROM NORMAL GROWTH LINE WITH SEASONAL FLUCTUATIONS

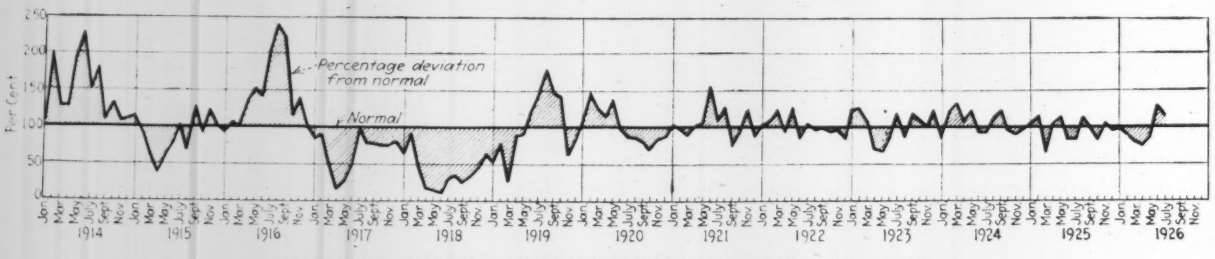


CHART II—ACCIDENTAL ELEMENT IN ROAD CONTRACT LETTING

IN GLANCING at a column of figures, such as the volume of construction in any branch of industry, the question that naturally comes to the mind is, "What is the *normal* amount of construction for a given month?" A statistical study of street and road construction has been made from *Engineering News-Record's* original data for the years 1913-26, in an effort to find the answer to this question specifically for roads.

The two chief things determining the amount of money spent on streets and roads are the increase in population and the seasonal influences. The original figures point to a steady upward trend—a straight line fitted to the data showing an average monthly increment of about $220,000. The percentage deviations around this trend line are plotted in Chart I. The seasonal fluctuations, represented by the dotted line, show a low amount of construction in January and February, a rapid increase in March and April, the peak reached in May and June, and a gradual falling off during the rest of the year.

Chart II is the final result, both the secular and the seasonal influences having been eliminated, and figures reduced to a percentage deviation from the calculated normal. A study of this chart does not reveal a tendency for the deviations to follow any regular cycle. We have very wide fluctuations in 1914-16, followed by a great amount of under-construction during the war years 1917, 1918 and the first part of 1919, and the effort to make up for this under-construction during the latter part of 1919 and the first part of 1920. From that time on, there has been a comparatively close relation to the estimated normal, only seven months deviating more than 25 per cent from the normal line. The causes of these deviations are probably more or less accidental, construction above the normal amount for one month being usually compensated for by a construction below normal the following month.

The amount of road building for the remaining three months of this year should approximately equal $82,000,000, making an annual total of about $420,000,000. The weekly rates for the remainder of the year should average as follows: in October, $8,500,000; November, $6,000,000; December, $4,800,000.